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HEATHKIT®
ASSEMBLY MANUAL

HEATHKIT® by Daystrom

DELUXE HAND-HELD TRANSCEIVER

MODEL GW-21

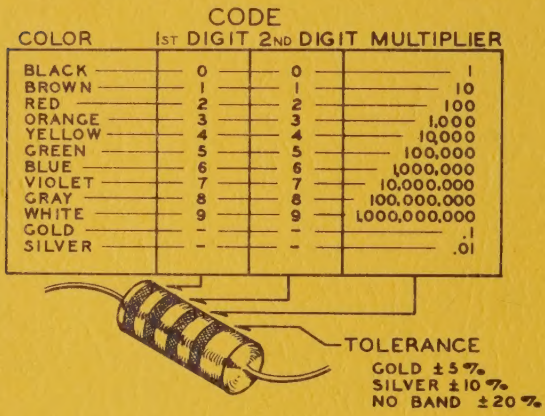
RESISTOR AND CAPACITOR COLOR CODES

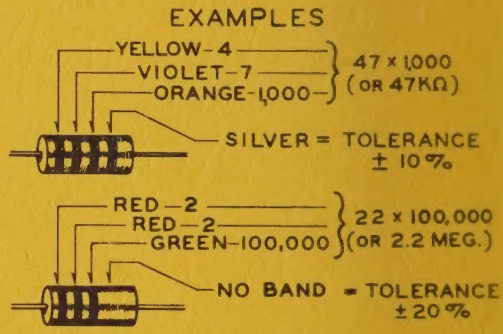
RESISTORS

The colored bands around the body of a color coded resistor represent its value in ohms. These colored bands are grouped toward one end of the resistor body. Starting with this end of the resistor, the first band represents the first digit of the resistance value; the second band represents the second digit; the third band represents the number by which the first two digits are multiplied. A fourth band of gold or silver represents a tolerance of ±5% or ±10% respectively. The absence of a fourth band indicates a tolerance of ±20%.

The physical size of a composition resistor is related to its wattage rating. Size increases progressively as the wattage rating is increased. The diameters of 1/2 watt, 1 watt and 2 watt resistors are approximately 1/8", 1/4" and 5/16", respectively.

The color code chart and examples which follow provide the information required to identify color coded resistors.

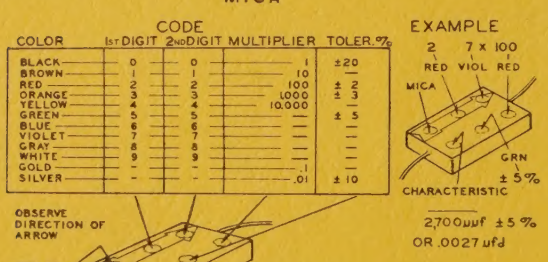




CAPACITORS

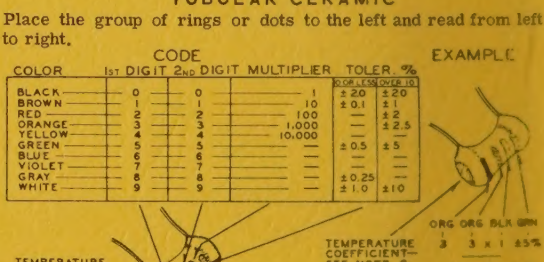
Generally, only mica and tubular ceramic capacitors, used in modern equipment, are color coded. The color codes differ somewhat among capacitor manufacturers, however the codes shown below apply to practically all of the mica and tubular ceramic capacitors that are in common use. These codes comply with EIA (Electronics Industries Association) Standards.

MICA



TUBULAR CERAMIC

Place the group of rings or dots to the left and read from left to right.


CODE
COLOR
1ST DIGIT
2ND DIGIT
MULTIPLIER
TOLER. %
10 OR LESS
OVER 10
BLACK 0 0 1 ±2.0 ±20
BROWN 1 1 10 ±0.1 ±1
RED 2 2 100 — ±2
ORANGE 3 3 1,000 — ±2.5
YELLOW 4 4 10,000 — —
GREEN 5 5 — ±0.5 ±5
BLUE 6 6 — — —
VIOLET 7 7 — — —
GRAY 8 8 — ±0.25 —
WHITE 9 9 — ±1.0 ±10
EXAMPLE
ORG ORG BLK GRN
3 3 x 1 ±5%
33 μμf ±5%
TEMPERATURE COEFFICIENT— SEE NOTE 2 BELOW.
TEMPERATURE COEFFICIENT— SEE NOTE 2 BELOW
(VALUE IN μμf—SEE NOTE 3 BELOW)

NOTES:

1. The characteristic of a mica capacitor is the temperature coefficient, drift capacitance and insulation resistance. This information is not usually needed to identify a capacitor but, if desired, it can be obtained by referring to EIA Standard, RS-153 (a Standard of Electronic Industries Association.)

2. The temperature coefficient of a capacitor is the predictable change in capacitance with temperature change and is expressed in parts per million per degree centigrade. Refer to EIA Standard, RS-198 (a Standard of Electronic Industries Association.)

3. The farad is the basic unit of capacitance, however capacitor values are generally expressed in terms of μfd (microfarad, .000001 farad) and μμf (micro-micro-farad, .000001 μfd); therefore, 1,000 μμf = .001 μfd, 1,000,000 μμf = 1μfd.

USING A PLASTIC NUT STARTER

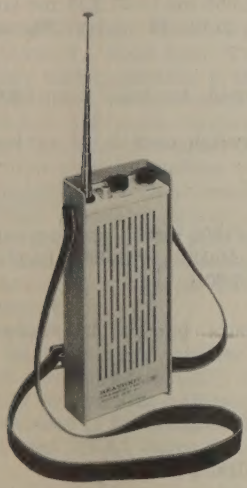
A plastic nut starter offers a convenient method of starting the most used sizes: 3/16" and 1/4" (3-48 and 6-32). When the correct end is pushed down over a nut, the pliable tool conforms to the shape of the nut and the nut is gently held while it is being picked up and started on the screw. The tool should only be used to start the nut.

Assembly
and
Operation
of the

HEATHKIT

DELUXE HAND-HELD TRANSCEIVER

MODEL GW-21



HEATH COMPANY,
BENTON HARBOR,
MICHIGAN

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*Fold-out from page.

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5/25/62

SPECIFICATIONS

RECEIVER SECTION	
Receiver Type	Crystal controlled, superheterodyne.
Sensitivity	1 microvolt for 10 db signal-to-noise ratio.
Selectivity	7.5 kc at 6 db.
Audio Power Output	150 milliwatts.
Controls	Off-On-Volume and Squelch.
TRANSMITTER SECTION	
* Input Power To Final Stage	100 milliwatts.
Frequency Unlicensed	Crystal controlled 26.97 mc to 27.255 mc (any channel, 2 through 23, in the 11-meter band).
* Frequency Licensed	Crystal controlled 26.965 mc to 27.255 mc (any channel, 1 through 23, in the 11-meter Citizen's Band).
Modulation	High level AM limited to less than 100%.
Control	Single push-to-talk switch on side of cabinet.
POWER SUPPLY	
** Battery	9 volt type, NEDA #1602 (such as Eveready #246, Burgess #2N6, Mallory #M1602, Ray-O-Vac #1602, or RCA #VS305).
Battery Life	Approximately 75 hours (normal intermittent use).
Total Receiver Current Drain, Standby	Approximately 12 milliamperes.
Total Transmitter Current Drain	Approximately 30 milliamperes.
GENERAL	
** Antenna	35" whip type, completely collapsible into cabinet.
Crystals	Subminiature, plug-in type, tolerance .005%.
Speaker-Microphone	2-1/2" round, permanent magnet type.

* Specify desired channel when ordering crystals. See the crystal list on Page 31.

Transistors And Diodes.	1 - 2N1726 RF amplifier. 1 - 2N1727 Converter. 2 - 2N1108 IF amplifier. 3 - 2N185 Audio amplifier 1 - R425 Transmitter oscillator. 1 - R424 RF amplifier. 1 - Germanium Diode-Detector. 1 - Silicon Diode - Squelch and noise limiter.
Cabinet Dimensions.	8" high x 3-5/8" wide x 1-5/8" deep.
Net Weight.	1-1/2 lbs.
Shipping Weight.	3 lbs.

** The antenna must not exceed 60" and the specified battery must be used to insure compliance with FCC Rules And Regulations, Part 15.

INTRODUCTION

The HEATHKIT Model GW-21 is a deluxe, 9-transistor, hand-held Transceiver, used for voice communication in the 11-meter Citizen's Radio Band. An RF amplifier circuit, as well as squelch and noise limiter circuits, have been built into the extremely sensitive crystal-controlled superheterodyne receiver section. The transmitter section consists of a crystal-controlled oscillator-driver stage and a modulated final amplifier. The audio section of the receiver is also used in the Transmit position to supply modulation voltage to the final amplifier in the transmitter.

A license is not required for operation of the unit over the frequency range of 26.97 mc to 27.27 mc, as long as it is operated in the manner described in the Federal Communications Commission (FCC) Rules and Regulations, Part 15.

The Transceiver may also be used as a licensed Citizen's Band unit in the manner described in the FCC Regulations, Part 19. An antenna jack is available on the control panel so an external antenna (not to exceed 60" when used unlicensed) may be used. Also, an earphone jack is provided on the control panel, so that a low impedance earphone (supplied with the unit) can be used for privacy or in noisy locations.

The range of the Transceiver will depend upon operating conditions. The practical range between two GW-21 Transceivers is approximately 1 to 3 miles, depending upon local conditions. If the unit is operated in a metropolitan area, or in a steel building, the range will decrease and possibly be extremely limited.

Among the many possible applications of the Transceiver are communications between a boat and shore, point-to-point communication in a factory, communication on a small farm, or as a roving microphone on the floor of a convention. Its compactness and versatility are such that it will find many helpful and enjoyable business and leisure time uses.

CIRCUIT DESCRIPTION

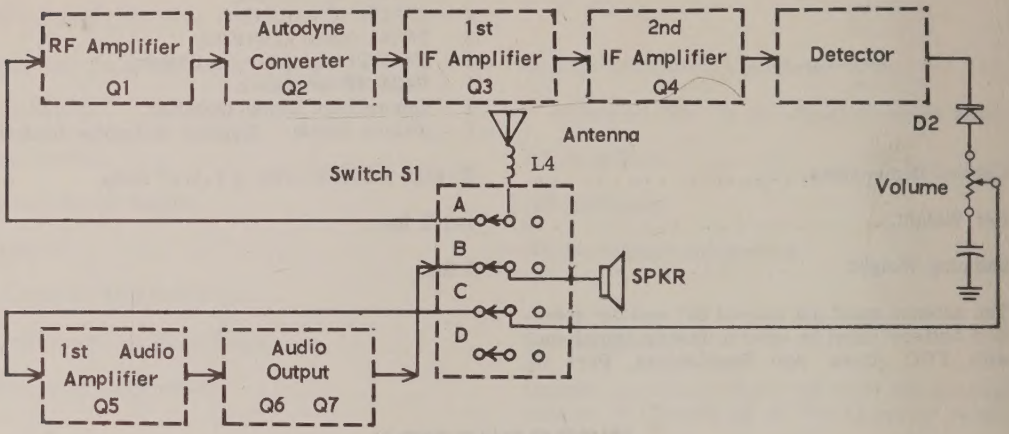


Figure 1

In order to make this circuit description easier to follow, the superheterodyne receiver circuits and the transmitter circuits will be described separately. Refer to the Schematic Diagram (fold-out from Page 7) as well as the Block Diagrams while reading this description.

RECEIVER

A signal received by the antenna is applied through loading coil L4 and through section A of switch S1 to the tap on antenna coil L1. Coil L1 and capacitor C1 form a resonant circuit which is tuned to receive the desired signal frequency.

From the input tuned circuit the signal is coupled through capacitor C2 to RF amplifier Q1. From the RF amplifier, the signal is coupled through the tuned primary and tuned secondary of mixer coil L2 to the autodyne converter stage, Q2.

Regenerative feedback through receiver crystal X1 causes the converter circuit to oscillate at a frequency 455 kc higher than the input frequency from the RF amplifier. The input signal and oscillator signal beat together in transistor Q2, resulting in a 455 kc difference (IF) signal that is coupled through coil L3 and IF input transformer T1 to the first IF amplifier, Q3. The purpose of coil L3 is to isolate the crystal from transformer T1. Capacitor C9 tunes L3 near the third overtone frequency of crystal X1.

The 455 kc IF signal is amplified in transistor Q3 and coupled through IF transformer T2 to the second IF amplifier, Q4. The IF signal from Q4 is coupled through IF output transformer T3 to the detector circuit, which consists of crystal D1 and capacitor C18. Resistor R18 is the diode load.

AVC voltage is developed by the detector diode and an AVC filter, consisting of resistor R14 (below Q4) and C12 (near Q3). The filtered AVC voltage is applied to the base returns of RF stage Q1 and IF amplifier stage Q3 to provide less amplification for strong signals. Resistor R3 (near Q1) supplies forward bias to the AVC line to insure a high gain for weak input signals.

Before following the audio signal through the audio amplifier circuits, the operation of the squelch circuits will be described. Figure 2 shows a simplified diagram of the squelch circuit.

The audio signal must pass through squelch diode D2 to get from the detector circuit to the volume control and audio amplifier circuits. The squelch diode acts like a gate for the audio signal; the opening and closing of the gate is determined

by the DC voltages across the diode. The DC voltages across the diode are determined by the voltages in the emitter and collector circuits of the 1st IF amplifier, and by the setting of the Squelch control.

The cathode of diode D2 connects back through R20 and R21 to the Squelch control. Squelch control R16, and resistor R17, are connected in a voltage divider between ground and the B- return in the collector circuit of IF amplifier Q3. The plate of squelch diode D2 connects back to the emitter of Q3 through the Volume control.

During no-signal operation, the cathode of D2 is held slightly positive with respect to the plate by the setting of the Squelch control. This prevents the diode from conducting and the audio signal cannot pass on to the Volume control.

When a signal is received, the AVC voltage increases and causes the current flowing through transistor Q3 to decrease. The decrease in current through Q3 causes the emitter to become less negative and the collector to become more negative.

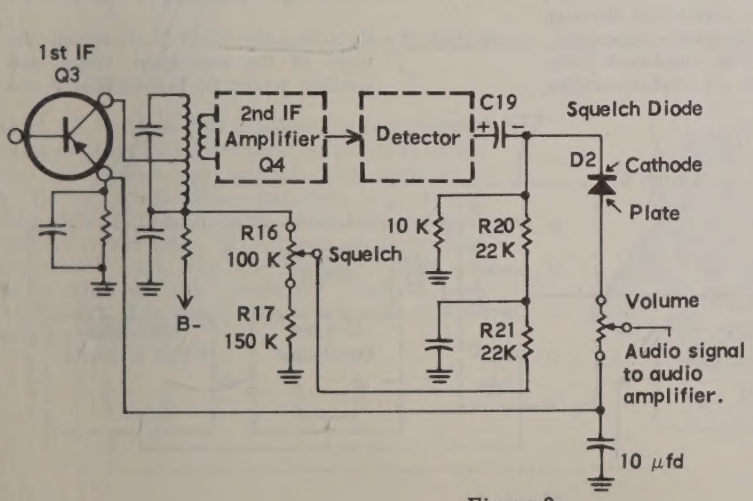
The more negative voltage at the collector of Q3 is reflected back through the Squelch control, R21 and R20, to the cathode of squelch diode D2. The more positive voltage at the emitter of Q3 is reflected back through the Volume control to the plate of diode D2. The more negative voltage at the cathode and the more positive voltage at the plate causes D2 to conduct and the audio signal is coupled to the Volume control, and from there to the audio amplifier circuits.

The Squelch control setting may be varied from the fully clockwise position, in which diode D2 is always conducting, to the fully counterclockwise position in which a very strong signal will be required to make D2 conduct.

Squelch diode D2 also acts as a series noise limiter since instantaneous noise peaks are clipped off because they increase the bias on D2 when they occur. The result is that diode D2 is cut off and the noise is greatly reduced in the audio section.

The audio signal from the Volume control couples through section C of switch S1, and through capacitor C21 to the input of 1st audio stage Q5. The signal from the collector of Q5 is coupled through driver transformer T4 to the output amplifier-modulator stage, which consists of transistors Q6 and Q7 connected in push-pull. The output of this stage is coupled through output transformer T5, through section B of switch S1 and through the shorted contacts of the Earphone Jack to the speaker.

Note that transformer T5 has two secondaries. In the Receive position, the upper secondary



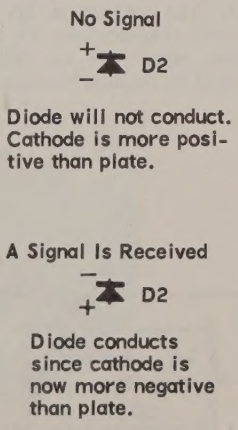


Figure 2

connects the audio output to the speaker and the lower secondary is not used. In the Transmit position, switch S1 disconnects the upper secondary and the lower secondary (or modulation winding) supplies the modulation signal to the transmitter section.

In the Receive position, switch S1 performs the following four operations:

Section A - Connects the antenna to RF amplifier Q1.

Section B - Connects the audio output signal through the Earphone Jack to the speaker.

Section C - Connects the arm of the Volume control to the input of the first audio amplifier, Q5.

Section D - Disconnects the ground returns of the transmitter stages and applies a short across the input of oscillator stage Q8 and the crystal to insure that no spurious oscillations will be heard in the receiver.

TRANSMITTER

When switch S1 is pushed in the Transmit position, the audio signal from the microphone (speaker) is connected through section C of switch S1 to the input of the first audio stage, Q5. The output of Q5 is connected through driver transformer T4 to the push-pull-modulator stage (Q6 and Q7). The amplified audio signal is coupled through the modulation winding of transformer T5 which is connected in series with the primary winding of output tank coil L6. This modulation winding of transformer T5 is deliberately mismatched to limit modulation to less than 100%.

The basic signal from which the transmitter output is derived is generated in a crystal oscillator circuit, which consists of transistor Q8 and third overtone crystal X2.

The output of the oscillator stage is coupled through coil L5 to the modulated final stage Q9. The output of the final is coupled through final RF tank coil L6 and through section A of switch S1 to the antenna. The output is also routed to the external antenna jack to which an external antenna may be connected (in the manner described in the FCC Rules and Regulations, Parts 15 and 19).

When the Transmit-Receive switch is pushed down into the Transmit position, it performs the following four operations:

Section A - Connects the antenna to final tank coil L6.

Section B - Disconnects the earphone or the speaker from the output of the audio amplifier.

Section C - Connects the speaker (microphone) to the input of first audio stage, Q5.

Section D - Removes the short from across the input of the oscillator stage, and applies power to the oscillator and

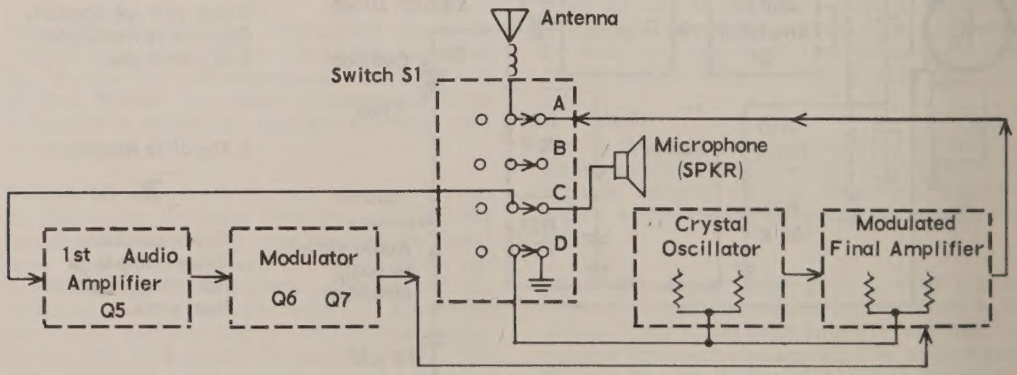


Figure 3

final stages by returning the resistors of these stages (and capacitor C32) to B-.

POWER SUPPLY

The operating power for the Transceiver is provided by a 9-volt battery. Resistor R30 and capacitor C25 decouple the audio output stage from the power connections to the rest of the receiver circuit to prevent instability. Switch S2, located on the rear of the Volume control, is used to turn the Transceiver off and on. For maximum battery life, be sure to turn switch S2 on only when the Transceiver is in actual use.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the Replacement section and supply the information called for therein. Include all inspection slips in your letter to us.

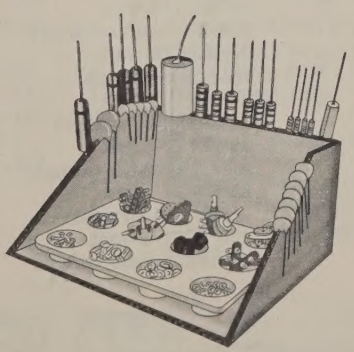
Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

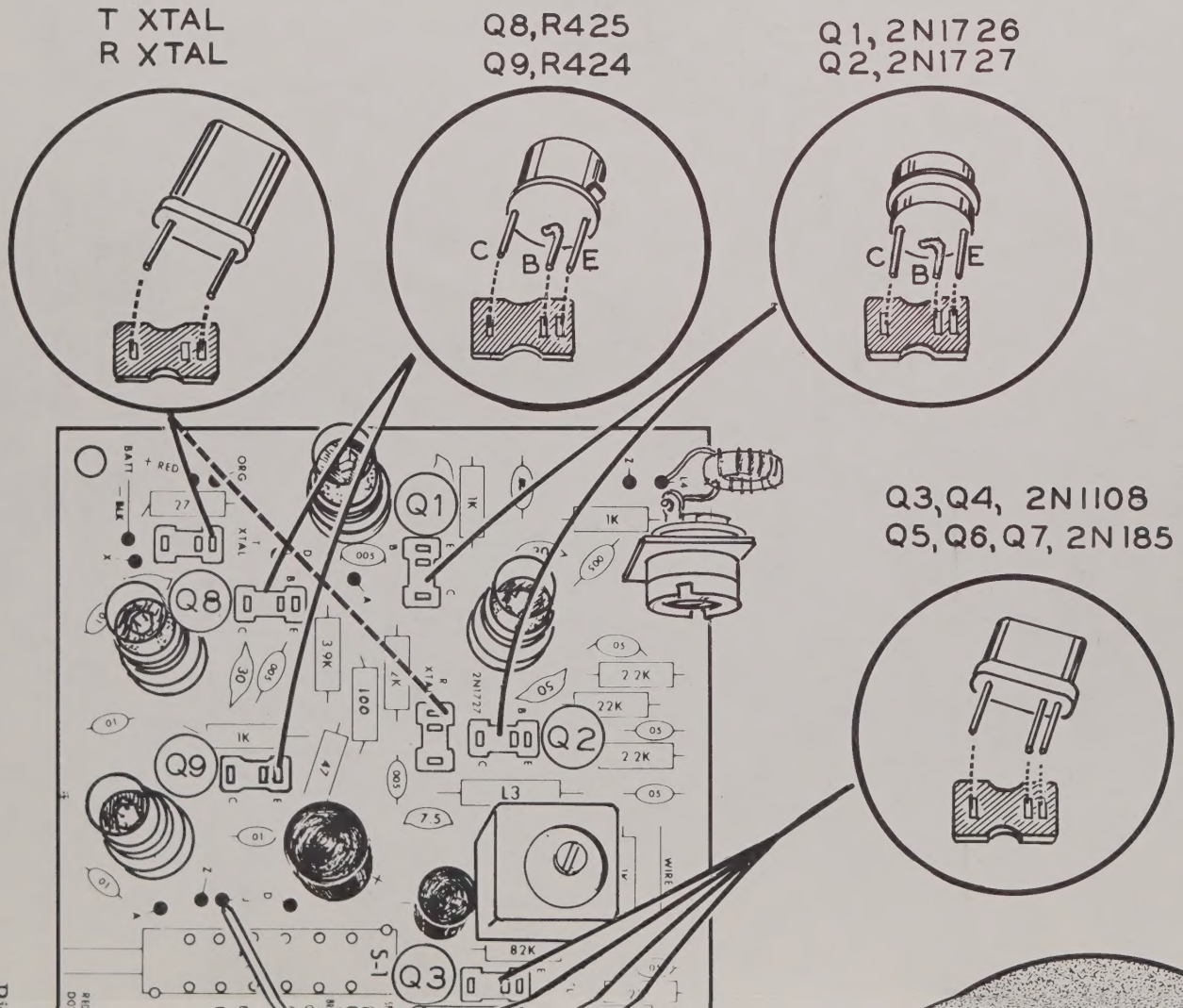
We suggest that you do the following before work is started:

1. Lay out all parts so that they are readily available.

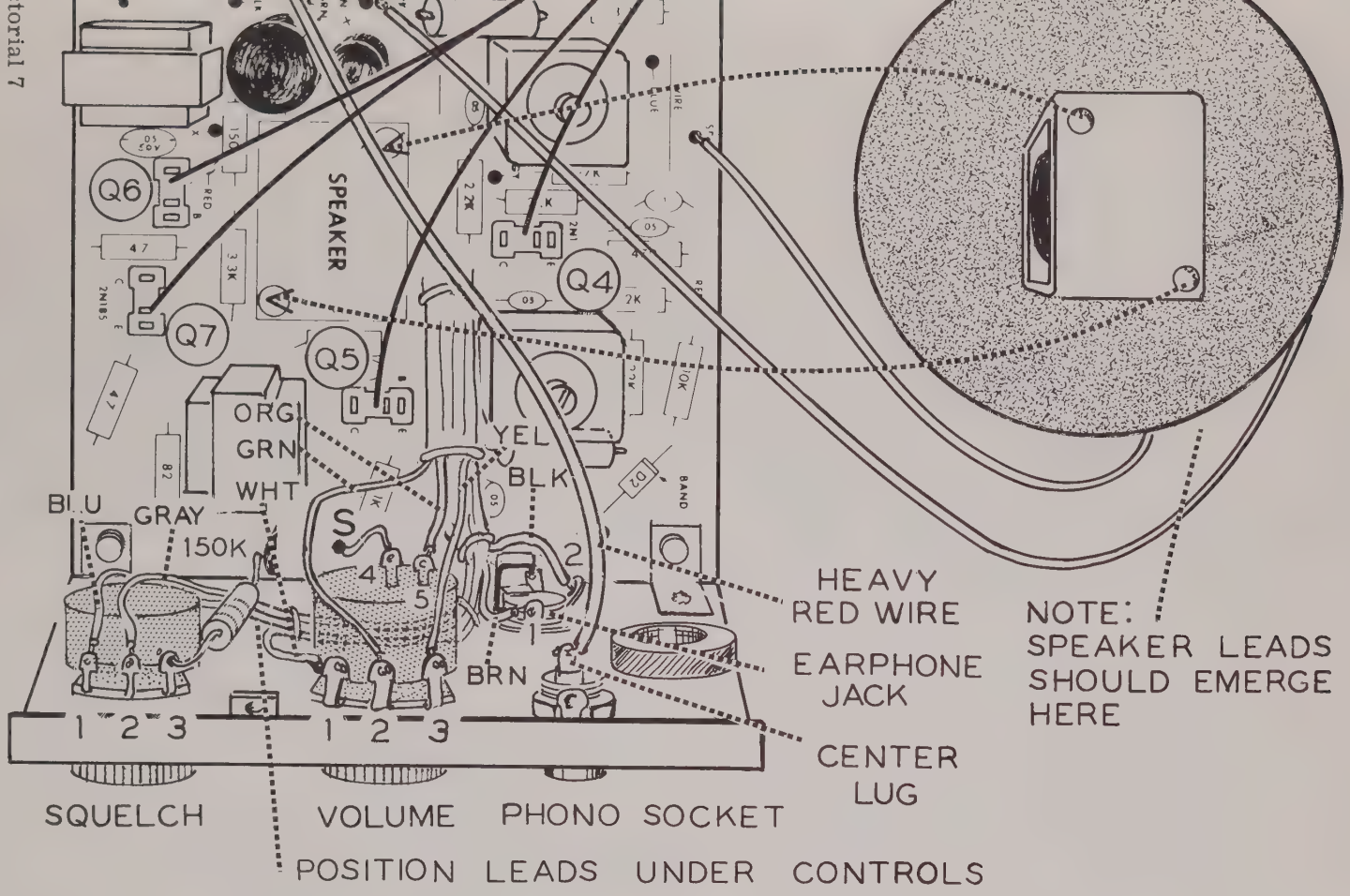
2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a pen knife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder.

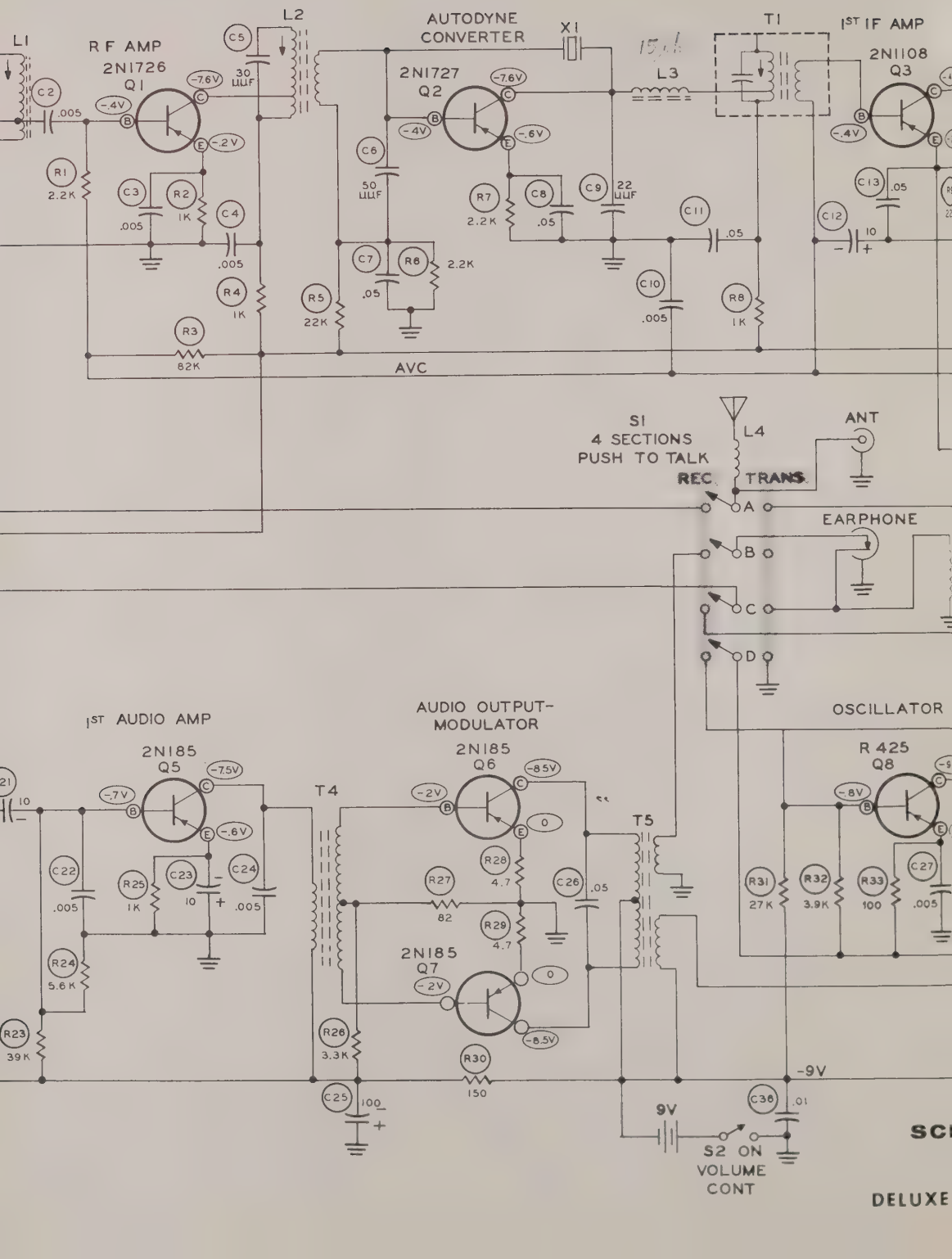
Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.

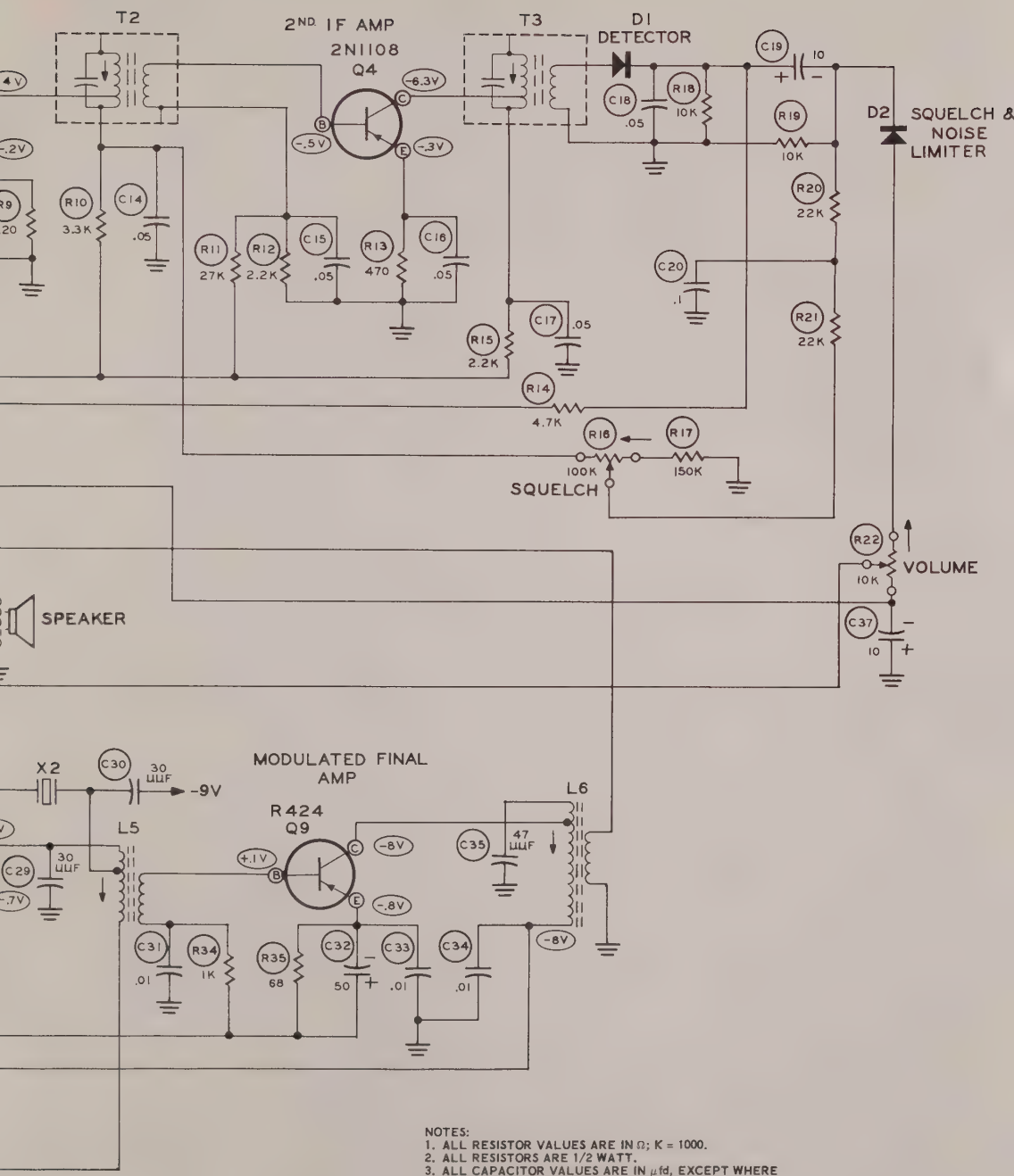



T XTAL
R XTAL
Q8,R425
Q9,R424
Q1, 2N1726
Q2, 2N1727
C B E
C B E
Q3,Q4, 2N1108
Q5,Q6,Q7, 2N185
BATT
+ RED
ORG
XTAL
Q1
Q8
Q9
Q2
Q3
L3
S-1
1K
3.9K
100
22K
82K
7.5
WIRE

Pi


Q6
Q7
Q5
Q4
SPEAKER
ORG
GRN
WHT
BLU
GRAY
150K
YEL
BLK
BRN
S
1 2 3
1 2 3
HEAVY RED WIRE
EARPHONE JACK
CENTER LUG
NOTE: SPEAKER LEADS SHOULD EMERGE HERE
SQUELCH
VOLUME
PHONO SOCKET
POSITION LEADS UNDER CONTROLS


L1
RF AMP
2N1726
Q1
L2
C5
30 UUF
C2
.005
-7.6V
-.4V
-.2V
R1
2.2K
C3
.005
R2
1K
C4
.005
R4
1K
R3
82K
R5
22K
AUTODYNE
CONVERTER
X1
2N1727
Q2
C6
50 UUF
C7
.05
R6
2.2K
R7
2.2K
C8
.05
C9
22 UUF
-.6V
L3
T1
C11
.05
C10
.005
R8
1K
AVC
1ST IF AMP
2N1108
Q3
C13
.05
C12
10
S1
4 SECTIONS
PUSH TO TALK
REC
TRANS
L4
ANT
A
B
C
D
EARPHONE
1ST AUDIO AMP
2N185
Q5
-7.5V
-7V
-6V
C22
.005
R25
1K
C23
10
C24
.005
R24
5.6K
R23
39K
T4
AUDIO OUTPUT-
MODULATOR
2N185
Q6
-8.5V
-2V
0
R28
4.7
R27
82
C26
.05
R29
4.7
2N185
Q7
-2V
0
-8.5V
R26
3.3K
R30
150
C25
100
T5
OSCILLATOR
R 425
Q8
-8V
R31
27K
R32
3.9K
R33
100
C27
.005
-9V
C36
.01
9V
S2 ON
VOLUME
CONT
SCI
DELUXE



NOTES:

1. ALL RESISTOR VALUES ARE IN Ω; K = 1000.
2. ALL RESISTORS ARE 1/2 WATT.
3. ALL CAPACITOR VALUES ARE IN μfd, EXCEPT WHERE MARKED μμf.
4. ⬭ INDICATES NEGATIVE DC VOLTAGE MEASUREMENT FROM POINT MARKED TO THE POSITIVE (+) BATTERY TERMINAL.
5. VOLTAGE MEASUREMENTS WERE MADE WITH S1 IN THE RECEIVE POSITION, EXCEPT THE VOLTAGES FOR Q8 AND Q9, WHICH WERE MEASURED WITH S1 PRESSED TO THE TRANSMIT POSITION.
6. S1 IS SHOWN IN THE RECEIVE POSITION.
7. ARROWS (⟶) ON CONTROLS INDICATE DIRECTION OF CLOCKWISE ROTATION.
8. VOLUME AND SQUELCH CONTROLS SET TO MAXIMUM CLOCKWISE POSITIONS FOR VOLTAGE MEASUREMENTS.

HEMATIC OF THE

HEATHKIT®

HAND-HELD TRANSCEIVER

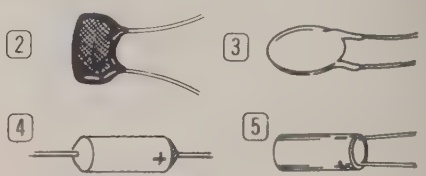
MODEL GW-21

PARTS LIST

The circled numbers in the Parts List are keyed to the circled numbers on the parts drawings to aid in parts identification.

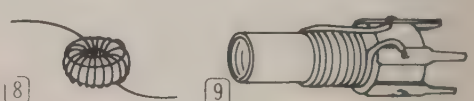
PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
① 1-129	2	4.7 Ω 1/2 watt (yellow-violet-gold)
1-2	1	68 Ω 1/2 watt (blue-gray-black)
1-118	1	82 Ω 1/2 watt (gray-red-black)
1-3	1	100 Ω 1/2 watt (brown-black-brown)
1-66	1	150 Ω 1/2 watt (brown-green-brown)
1-45	1	220 Ω 1/2 watt (red-red-brown)
1-6	1	470 Ω 1/2 watt (yellow-violet-brown)
1-9	5	1 KΩ 1/2 watt (brown-black-red)
1-44	5	2.2 KΩ 1/2 watt (red-red-red)
1-122	2	3.3 KΩ 1/2 watt (orange-orange-red)
1-46	1	3.9 KΩ 1/2 watt (orange-white-red)
1-16	1	4.7 KΩ 1/2 watt (yellow-violet-red)
1-18	1	5.6 KΩ 1/2 watt (green-blue-red)
1-20	2	10 KΩ 1/2 watt (brown-black-orange)
1-22	3	22 KΩ 1/2 watt (red-red-orange)
1-23	2	27 KΩ 1/2 watt (red-violet-orange)
1-67	1	39 KΩ 1/2 watt (orange-white-orange)
1-102	1	82 KΩ 1/2 watt (gray-red-orange)
1-27	1	150 KΩ 1/2 watt (brown-green-yellow)

PART No.	PARTS Per Kit	DESCRIPTION
Capacitors		
② 20-99	1	22 μμf mica
20-100	4	30 μμf mica
20-101	1	47 μμf mica
20-97	1	50 μμf mica
③ 21-46	7	.005 μfd disc
21-47	4	.01 μfd disc
21-48	1	.05 μfd disc, 50 volt
21-94	9	.05 μfd disc, 10 volt
21-95	1	.1 μfd disc
④ 25-54	2	10 μfd electrolytic, 10 volt
⑤ 25-115	3	10 μfd electrolytic, 12 volt
25-116	1	50 μfd electrolytic, 10 volt
25-117	1	100 μfd electrolytic,12 volt

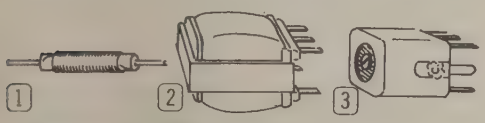


Controls-Switch		
10-125	1	100 KΩ control
⑥ 19-69	1	10 KΩ control with switch
⑦ 1064-15	1	Switch

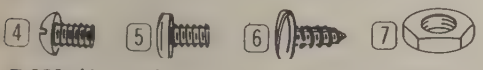
Coils-Transformers		
⑧ 40-430	1	Toroid coil
⑨ 40-388	1	Antenna coil
40-389	1	Mixer coil
40-390	1	Oscillator coil
40-391	1	Transmitter tank coil



PART No.	PARTS Per Kit	DESCRIPTION
Coils-Transformers (cont'd.)		
[1] 45-51	1	15 μh choke
[2] 51-78	1	Audio interstage transformer
51-79	1	Audio output - modulation transformer
[3] 52-44	1	IF input transformer
52-45	1	IF interstage transformer
52-46	1	IF output transformer

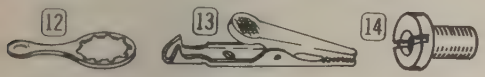


Hardware		
[4] 250-31	2	6-32 screw, round head
[5] 250-56	5	6-32 screw, binder head
[6] 250-170	2	#6 sheet metal screw
[7] 252-39	3	1/4" - 32 nut

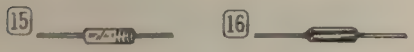


[8] 253-49	1	1/4" nylon flat washer
[9] 253-50	1	1/4" nylon shoulder washer
[10] 254-1	2	#6 lockwasher
[11] 254-14	3	1/4" lockwasher

[12] 259-12	2	1/4" solder lug
[13] 260-16	2	Alligator clip
[14] 455-31	1	Antenna bushing

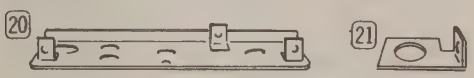


Diodes-Transistors		
[15] 56-4	1	Crystal diode
[16] 56-10	1	Silicon diode
417-51	3	2N185 transistor
417-11	2	2N1108 transistor
417-33	1	R424 transistor
417-36	1	R425 transistor
417-37	1	2N1726 transistor
417-38	1	2N1727 transistor

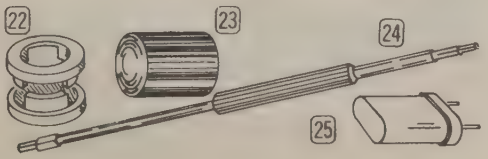


PART No.	PARTS Per Kit	DESCRIPTION
Wire-Sockets		
134-39	1	Wire harness
344-1	1	Length hookup wire, small
344-3	1	Length hookup wire, large
[17] 432-33	1	Battery connector
[18] 434-103	11	Transistor socket
[19] 434-107	1	Phono socket

Sheet Metal Parts		
100-M374		Cabinet
[20] 100-M339F584		
	1	Control panel
[21] 204-434	1	Antenna mounting bracket
100-M358	1	Front panel



Miscellaneous		
[22] 73-27	1	Plastic grommet, 2-piece
85-37F582	1	Circuit board
1142-42	1	Whip antenna
267-2	1	Leather strap
330-10	1	Felt damping pad
390-113	1	Transmitter identification label
390-117	1	Battery replacement label
390-118	1	Certification label
1401-61	1	Speaker
1401-62	1	Earphone assembly, with earphone jack
412-19	1	Pilot lamp, #1804
[23] 462-143	1	Knob, pushbutton
462-154	2	Knob
[24] 490-1	1	Plastic alignment tool
595-474	1	Manual
	1	Crystal, Transmitter
[25]	1	Crystal, Receiver
	1	Citizen's Band License Packet



CIRCUIT BOARD WIRING AND SOLDERING

Before attempting any work on the circuit boards, read the following instructions carefully and study the Figures. It is only necessary to observe the following basic precautions to insure proper operation of the unit the first time it is turned on.

Proper mounting of components on the board is essential for good performance. A good general rule to follow is that all components on the board should be mounted tightly to the board, unless instructions state otherwise. All leads should be kept as short as possible to minimize the effects of stray capacity in the wiring. Proper and improper methods of mounting are illustrated in the accompanying Figures.

NOTE: Exercise care not to damage resistors or capacitors when bending the leads as shown.

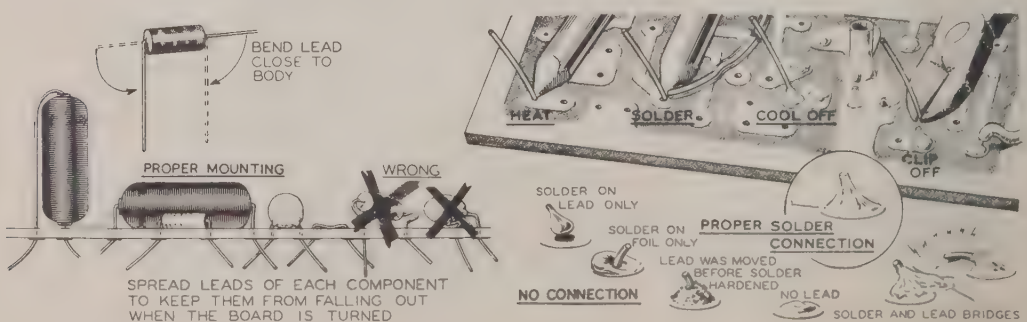
Tubular capacitors and resistors will fit properly if the leads are bent as shown. Disc capacitors will generally fit in place with no lead preparation other than determining that the leads are straight. Components with lugs normally require no preparation unless the lugs appear to be bent, in which case they can be straightened with pliers.

Parts should be inserted as instructed, and the leads bent outward, as illustrated, to lock them in place. After the part is in position, cut the leads off about 1/4" from the board. When a group of parts have been installed on a circuit board, solder each lead to the foil pattern and clip off the excess wire.

The actual technique of soldering leads to a circuit board is quite simple. Position the tip of the soldering iron so that it firmly contacts both the circuit board foil and the wire or lug to be soldered, as shown. The iron should be held so that solder is not likely to flow to adjacent foil conductors or connections. The solder should immediately be placed between the iron and the joint to be soldered. Remove the length of solder as soon as its end begins to melt and flow onto the lead and foil. Hold the tip of the iron in place only until the solder begins to flow outward over the foil; then remove the iron quickly.

Avoid overheating the connection. A soldering pencil or small iron (approximately 30 watts) is ideal for use in circuit board work. If only a high wattage iron or soldering gun is available, precautions must be taken to avoid circuit board damage due to overheating and excess solder.

The use of excessive amounts of solder will increase the possibility of bridging between foil conductors or plugging holes which are to be left open for wires which may be added later on. If solder is accidentally bridged across insulating areas between conductors, it can be cleaned off by heating the connection carefully and quickly wiping or brushing the solder away with a soft cloth or clean brush. Holes which become plugged can be cleared by heating the area immediately over the hole while gently pushing the lead of a resistor through the hole from the opposite side, and withdrawing the lead before the solder rehardens. Do not force the lead through; too much pressure before the solder has time to soften may separate the foil from the board.



In cases where foil does become damaged, repairs can usually be made with little difficulty. A break in the foil can be rejoined with a small piece of bare wire soldered across the gap, or between the foil and the lead of a component. "Hairline" breaks can usually be repaired by bridging them with a small amount of solder.

NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.

STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each lead in colored pencil on the Pictorial as it is added.

The fold-out diagrams in this manual may be removed and attached to the wall above your working area; but, because they are an integral part of the instructions, they should be returned to the manual after the kit is completed.

In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustrations may be slightly distorted to facilitate clearly showing all of the parts.

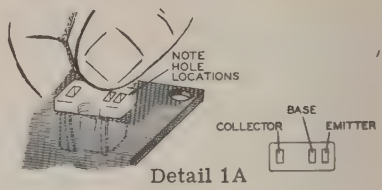
The steps directing the installation of resistors include color codes to help identify the parts. Also, if a part is identified by a letter-number designation on the Schematic, its designation will appear at the beginning of the construction step which directs its installation.

STEP-BY-STEP ASSEMBLY

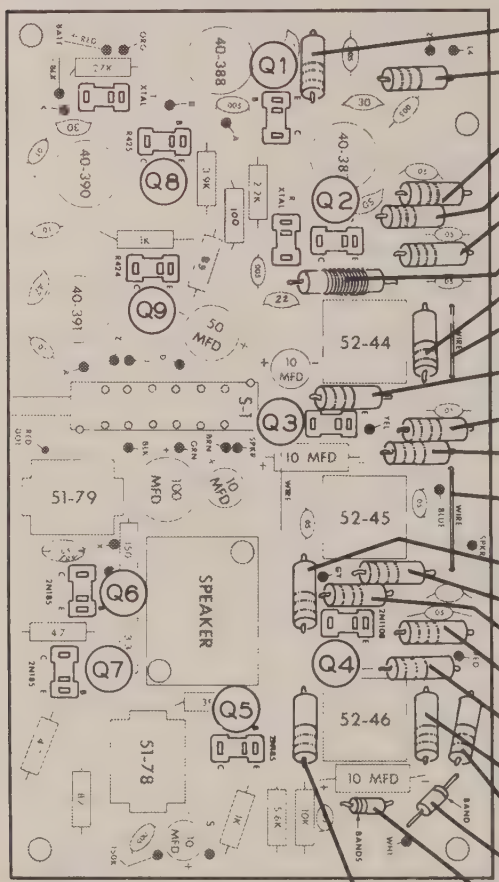
CIRCUIT BOARD ASSEMBLY

( ) Place the circuit board on your work surface as shown in Pictorial 1, with the lettered side up.

Install the indicated part to complete each of the following steps.



Detail 1A



Pictorial 1

START

( ) Install transistor sockets Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, and the crystal sockets as shown in Detail 1A. Be sure that each socket is mounted so that its holes are in the same positions shown in Pictorial 1. Solder all of the pins of each socket in the circuit board.

( ) R2. 1 KΩ (brown-black-red).

( ) R4. 1 KΩ (brown-black-red).

( ) R6. 2.2 KΩ (red-red-red).

( ) R5. 22 KΩ (red-red-orange).

( ) R7. 2.2 KΩ (red-red-red).

( ) L3. 15 μh choke.

( ) R8. 1 KΩ (brown-black-red).

( ) Install a bare wire as (use one of the cut-off resistor leads) shown near resistor R8.

( ) R3. 82 KΩ (gray-red-orange).

( ) R9. 220 Ω (red-red-brown).

( ) R10. 3.3 KΩ (orange-orange-red).

( ) Install a bare wire (use one of the cut-off resistor leads) as shown below resistor R10.

( ) R12. 2.2 KΩ (red-red-red).

( ) R11. 27 KΩ (red-violet-orange).

( ) R21. 22 KΩ (red-red-orange).

( ) R13. 470 Ω (yellow-violet-brown).

( ) R15. 2.2 KΩ (red-red-red).

( ) R20. 22 KΩ (red-red-orange).

( ) R19. 10 KΩ (brown-black-orange).

( ) D2. Silicon diode (dark body). Note the position of the banded end of this diode.

( ) D1. Crystal diode (red-green-violet). Note the position of the banded end of this crystal diode.

( ) R14. 4.7 KΩ (yellow-violet-red).

( ) Now solder all connections and then clip off all excess leads so they do not protrude further than 1/8" below the circuit board.

( ) C2. .005 μfd disc capacitor.

( ) R1. 2.2 KΩ (red-red-red).

( ) R31. 27 KΩ (red-violet-orange).

( ) R32. 3.9 KΩ (orange-white-red).

( ) C27. .005 μfd disc capacitor.

( ) C36. .01 μfd disc capacitor.

( ) R33. 100 Ω (brown-black-brown).

( ) R34. 1 KΩ (brown-black-red).

( ) C35. 47 μμf mica capacitor.

( ) R35. 68 Ω (blue-gray-black).

( ) C34. .01 μfd disc capacitor.

( ) C33. .01 μfd disc capacitor.

( ) Install a bare wire as shown near socket Q3 (use one of the clipped off capacitor wires).

( ) C26. .05 μfd disc, 50 volts.

( ) R30. 150 Ω (brown-green-brown).

( ) R28. 4.7 Ω (yellow-violet-gold).

( ) R26. 3.3 KΩ (orange-orange-red).

( ) R29. 4.7 Ω (yellow-violet-gold).

( ) R23. 39 KΩ (orange-white-orange).

( ) R27. 82 Ω (gray-red-black).

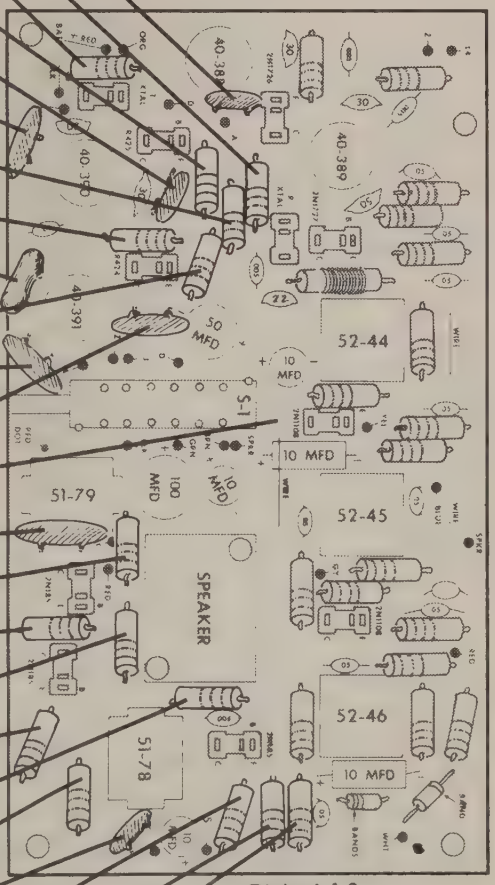
( ) C24. .005 μfd disc capacitor.

( ) R25. 1 KΩ (brown-black-red).

( ) R24. 5.6 KΩ (green-blue-red).

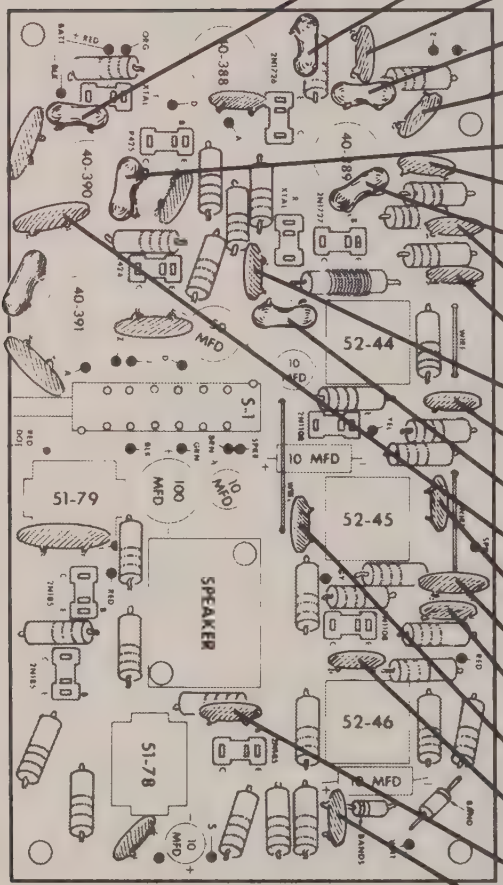
( ) R18. 10 KΩ (brown-black-orange).

( ) Now solder all connections and clip off all excess leads.



Pictorial 2

NOTE: Save two of the longer bare wires that you clip from the capacitor leads. They will be used in a later part of the manual.



Pictorial 3

( ) C30. 30 μμf mica capacitor.

( ) C1. 30 μμf mica capacitor.

( ) C3. .005 μfd disc capacitor.

( ) C5. 30 μμf mica capacitor.

( ) C4. .005 μfd disc capacitor.

( ) C29. 30 μμf mica capacitor.

( ) C7. .05 μfd disc capacitor, 10 V.

( ) C6. 50 μμf mica capacitor.

( ) C8. .05 μfd disc capacitor, 10 V.

( ) C11. .05 μfd disc capacitor, 10 V.

( ) C10. .005 μfd disc capacitor.

( ) C13. .05 μfd disc capacitor, 10 V.

( ) C9. 22 μμf mica capacitor.

( ) C31. .01 μfd disc capacitor.

( ) C14. .05 μfd disc capacitor, 10 V.

( ) C20. .1 μfd disc capacitor.

( ) C16. .05 μfd disc capacitor, 10 V.

( ) C15. .05 μfd disc capacitor, 10 V.

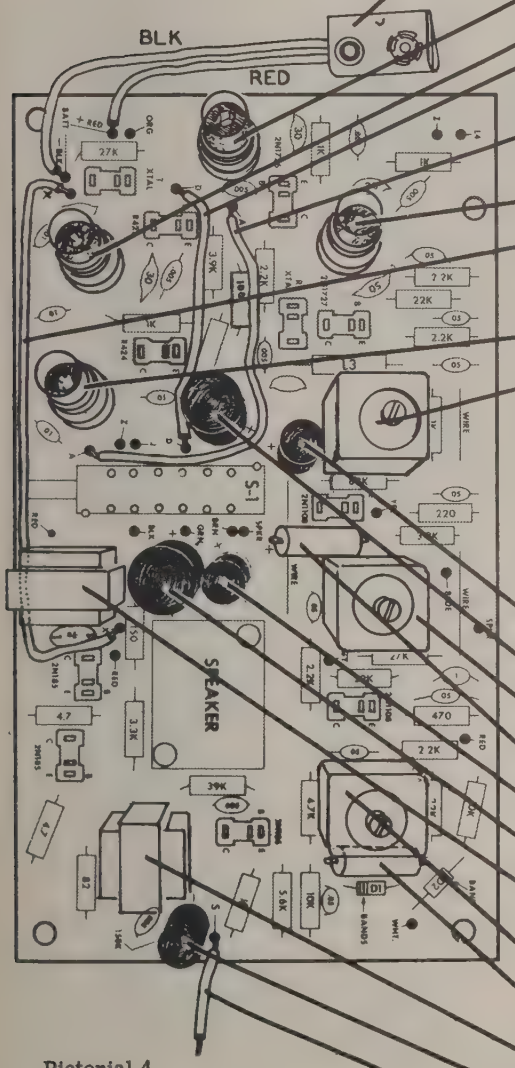
( ) C17. .05 μfd disc capacitor, 10 V.

( ) C22. .005 μfd disc capacitor.

( ) C18. .05 μfd disc capacitor, 10 V.

( ) Now solder all connections and then clip all excess leads. Push capacitor C18 down flat against diode D1 and the circuit board.

NOTE: Strip 1/4" of insulation from the ends of hookup wires when preparing to connect them to the circuit board.



Pictorial 4

( ) Now solder all connections and then clip off all excess leads.

( ) Install the battery connector. Cut both leads to a length of 2" and strip 1/4" of insulation from the end of each lead. Connect the black lead to the -BLK. hole and the red lead to the +RED hole.

( ) L1. Install the antenna coil (#40-388).

( ) L5. Install the oscillator coil (#40-390).

( ) Connect a 2-1/4" hookup wire from hole D to hole D.

( ) Connect a 3" hookup wire from hole A to hole A. Route this wire as shown.

( ) L2. Install the mixer coil (#40-389).

( ) Connect a 4-1/4" hookup wire from point X near C30 to point X near transistor socket Q6. Route the wire as shown.

( ) L6. Install the transmitter tank coil (#40-391).

( ) T1. IF input transformer (#52-44).

NOTE: In the following steps, a number of electrolytic capacitors will be installed. Note that there is a plus (+) mark near one lead and a minus (-) mark near the other lead of each electrolytic capacitor. Be sure when installing these capacitors that the plus and minus markings are in the same positions as the plus and minus markings on the circuit board.

( ) C12. 10 μfd electrolytic capacitor.

( ) C32. 50 μfd electrolytic capacitor.

( ) T2. IF interstage transformer (#52-45).

( ) C37. 10 μfd electrolytic capacitor (double ended type).

( ) C21. 10 μfd electrolytic capacitor.

( ) C25. 100 μfd electrolytic capacitor.

( ) T5. Audio output-modulation transformer (#51-79). Put the red dot on the transformer near the red dot on the circuit board.

( ) T3. IF output transformer (#52-46).

( ) C19. 10 μfd electrolytic capacitor (double ended type).

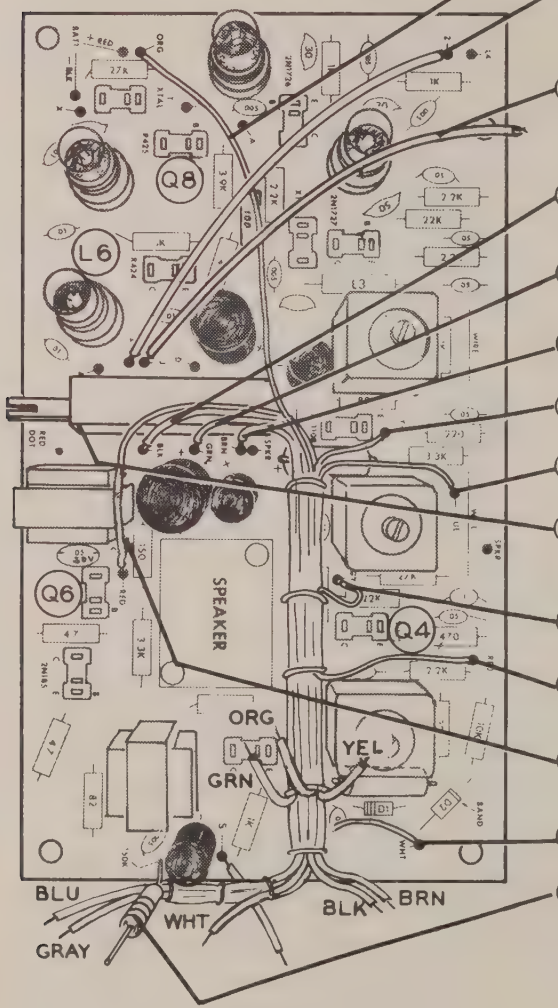
( ) T4. Audio interstage transformer (#51-78).

( ) C23. 10 μfd electrolytic capacitor.

( ) Connect a 1-1/2" hookup wire at hole S. Strip 1/4" of insulation from both ends of this wire, and let the other end hang free; it will be connected later.

Complete the steps below by installing the wires as directed.

( ) Place the harness on the circuit board as it is shown, with the long orange wire routed toward the upper corner, near transistor socket Q8.



Pictorial 5

( ) Connect this long orange wire to the hole marked ORG.

( ) Connect a 4-1/4" length of large hookup wire from hole Z near coil L6 to hole Z in the upper right-hand corner of the board. Solder the connections.

( ) Connect one end of a 4-1/2" length of large hookup wire to hole J near coil L6. Solder the connection. The other end of this wire will be connected later.

( ) Connect the black wire to the hole marked BLK.

( ) Connect the green wire to the hole marked GRN.

( ) Connect the brown wire to the hole marked BRN.

( ) Connect the yellow wire to the hole marked YEL.

( ) Connect the blue wire to the hole marked BLUE.

( ) Mount switch S1. Make sure the switch is pressed firmly against the board, and then solder all of the pins.

( ) Connect the gray wire to the hole marked GY.

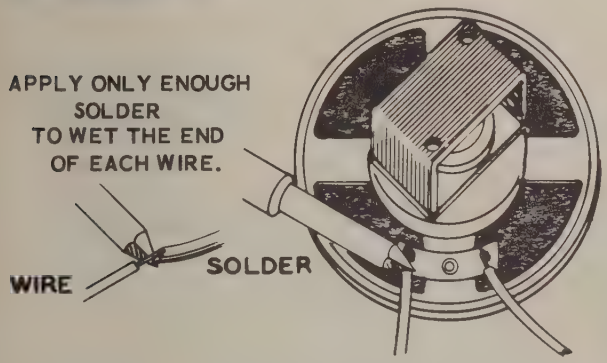
( ) Connect this red wire to the hole marked RED near Q4.

( ) Route this red wire as shown and connect it to the hole marked RED near Q6.

( ) Connect the nearest end of the white wire to the hole marked WHT.

( ) R17. Cut each lead of a 150 KΩ (brown-green-yellow) 1/2 watt resistor to a length of 1/2". Connect the end of one lead of this resistor to the circuit board through the hole marked 150 K and solder the connection. The other lead of this resistor will be connected later.

( ) Make sure all connections are soldered, and then clip off all excess leads.



1. HOLD WIRE AGAINST TERMINAL.
2. HEAT WITH IRON UNTIL SOLDER FLOWS AROUND WIRE.
3. REMOVE IRON AND HOLD WIRE STEADY UNTIL JOINT COOLS.

Detail 5A

SPEAKER PREPARATION

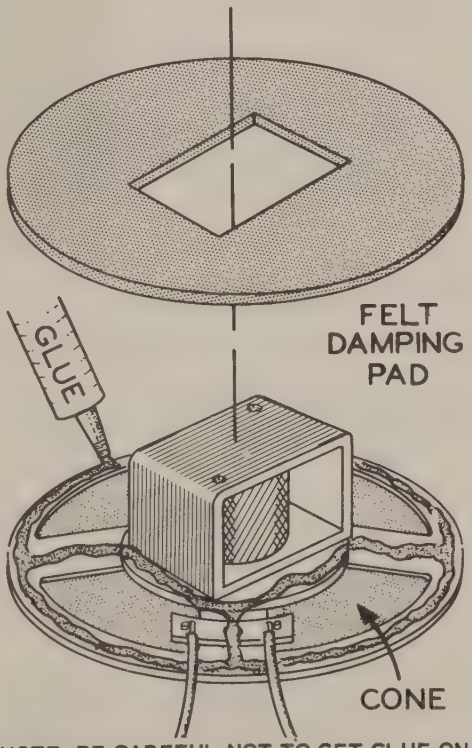
Prepare the speaker wires and connect them to the speaker in the following manner.

Refer to Detail 5A.

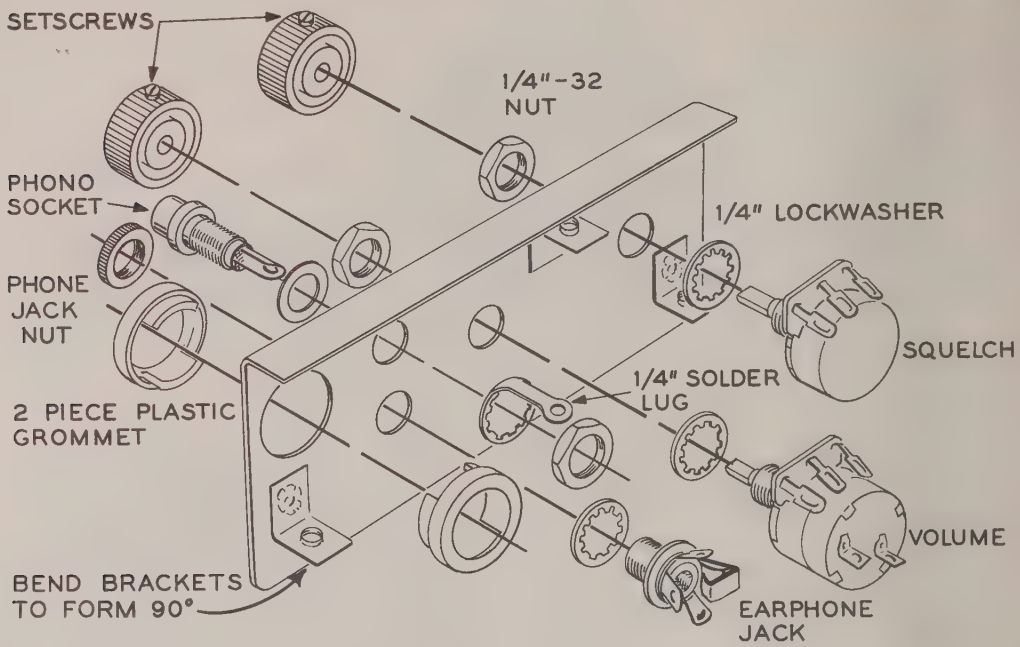
( ) Cut two 5-1/4" lengths of hookup wire. Strip 1/8" to 3/16" insulation from both ends of each wire. Melt a small amount of solder on one end of each wire.

( ) Connect these wires to the speaker terminals by following the directions in Detail 5A.

( ) Glue the felt damping pad to the rear of the speaker as shown in Detail 5B. Apply a bead of any all-purpose glue around the metal frame on the back of the speaker, and then glue the felt pad to the frame. Now set the speaker to one side while the glue sets and proceed with the following steps.



Detail 5B



Pictorial 6

CONTROL PANEL ASSEMBLY

Refer to Pictorial 6 for the following steps.

( ) Install the two piece plastic grommet in the large hole in the control panel. Press the two halves of the grommet together, one from each side of the hole as shown.

( ) R16. Install the 100 KΩ Squelch control as shown, at the other end of the control panel, with a 1/4" lockwasher behind the panel and a 1/4"-32 nut in front of the panel. Be sure to direct the lugs of the control as shown.

( ) Remove the earphone jack from the small package containing the earphone assembly. Fasten this jack to the control panel, using the nut supplied with the jack, orient the lugs as they are shown in Pictorial 6. Place a 1/4" lockwasher between the jack and the panel.

( ) Remove the nut, solder lug, and one of the washers from the phono socket, discard the solder lug and washer. Install the phono socket through the control panel. Bend the solder tab of a 1/4" solder lug over 90 degrees, install it over the threads of the phono socket, and fasten it and the phono socket in place with the nut previously removed from the phono socket. Position the solder lug as it is shown in Pictorial 6.

( ) R22. Install the 10 KΩ Volume control with a 1/4" lockwasher and a 1/4"-32 nut. Place the lugs in the position shown.

( ) Install the two knobs, one on the shaft of each control, by tightening each setscrew down on the flatted part of its shaft.

FINAL WIRING

Refer to Pictorial 7 (fold-out from Page 8) for the following steps.

( ) Place the control panel in position as shown at the end of the circuit board near transistor socket Q5.

( ) Push the 150 KΩ resistor up so that it rests against transformer T4.

( ) Connect the short hookup wire from hole S to lug 4 of the Volume control. Solder the connection.

Connect the harness wires to the control panel as directed in the following steps, and solder the connections.

( ) Connect the white wire to lug 1 of the Volume control.

( ) Connect the blue wire to lug 1 of the Squelch control.

( ) Connect the gray wire to lug 2 of the Squelch control.

( ) Connect the orange wire to lug 5 of the Volume control.

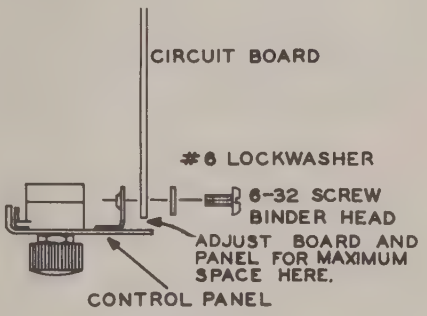
( ) Connect the green wire to lug 2 of the Volume control.

( ) Connect the yellow wire to lug 3 of the Volume control.

( ) Connect the brown wire to lug 1 of the Earphone Jack.

( ) Connect the black wire to lug 2 of the Earphone Jack.

( ) Fasten the control panel to the circuit board as shown in Detail 7A by installing two 6-32 binder head screws, with #6 lockwashers through the circuit board into the tapped holes in the mounting brackets for the control panel.

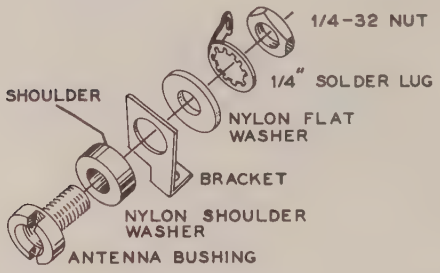


Detail 7A

( ) Connect the free lead of the 150 KΩ resistor to lug 3 of the Squelch control and solder the connection.

( ) Connect the free end of the heavy hookup wire from hole J to the center lug of the phono socket and solder the connection.

( ) Place the antenna bushing through the nylon shoulder washer and install it on the antenna mounting bracket as shown in Detail 7B. Place a flat nylon washer on the other side of the bracket and place the 1/4" solder lug (oriented as shown) over the bushing. Fasten the assembly together with a 1/4"-32 nut.



Detail 7B

( ) Connect one lead of the toroid coil (#40-430) to the solder lug on the antenna bushing and solder the connection.

( ) Place the antenna mounting bracket over its mounting hole at the corner of the circuit board. Connect the other lead of the toroid coil to the hole marked L4 in the corner of the board and solder the connection.

( ) Place the speaker as shown in Pictorial 7. Connect one speaker lead to each of the holes marked SPKR.

( ) Remove the three 2N185 transistors from their envelope and note the color dot on the top of each transistor.

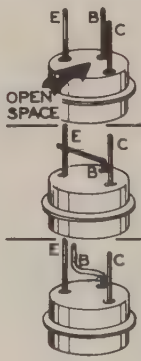
( ) Install the two 2N185 transistors with identical color dots in sockets Q6 and Q7.

( ) Install the other 2N185 transistor in socket Q5.

( ) Install one 2N1108 transistor in socket Q4.

( ) Install the other 2N1108 transistor in socket Q3.

( ) Since each of the four remaining transistors have round bases, their leads must be prepared in the manner shown in Detail 7C so that they will plug into the sockets properly.



1. Cut each lead to 3/8".
2. Position the transistor with open space as shown for the next two steps.
3. Bend pin B over toward pin E, as shown.
4. Now bend pin B up near pin E, so that all three pins lie in a straight line.

Do not let pin B touch the metal part of the transistor.

Detail 7C

( ) Install the 2N1727 transistor in transistor socket Q2.

( ) Install the 2N1726 transistor in transistor socket Q1.

( ) Install the R424 transistor in transistor socket Q9.

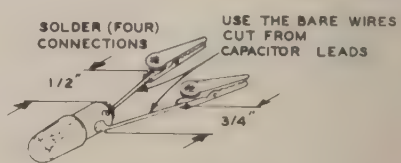
( ) Install the R425 transistor in transistor socket Q8.

( ) Install the receiver crystal in the R XTAL socket, and install the transmitter crystal in the T XTAL socket.

NOTE: Carefully move all obstructions (wire and components) out of the way so the speaker will mount flush on the circuit board.

( ) Fasten the speaker to the circuit board by aligning the tapped holes on the base of the speaker with the two mounting holes in the SPEAKER position on the circuit board. Secure the speaker from below the circuit board with two 6-32 round head screws.

( ) Construct a dummy load for the transmitter as shown in Detail 7D. Use two lengths of clipped off capacitor leads.



Detail 7D

( ) Bend the three lugs of the Volume control and Squelch control downward slightly to make sure they will not be shorted when the front panel is installed.

This completes the wiring of your Transceiver. Check the base of the circuit board carefully for any points that have not been soldered or for any large blobs of solder shorting across two foils. If all appears normal, proceed on to the Alignment section.

ALIGNMENT

INITIAL TEST

NOTE: While the receiver is not mounted in its cabinet, do not allow it to rest on a metal surface, since the metal surface could cause temporary short circuits on the circuit board.

Refer to Figure 4 (fold-out from Page 23) for the following steps.

( ) Install the battery connector on the battery (see the Specifications section for a list of the correct types of batteries).

( ) Turn the Volume control and the Squelch control to their fully clockwise positions.

( ) Push the transmit button in, a click should be heard in the speaker. If a click is heard, proceed with the alignment. If no click is heard, refer to the In Case Of Difficulty section.

For your convenience, two different alignment procedures are presented here, alignment without instruments, and an alignment chart for instrument alignment.

ALIGNMENT WITHOUT INSTRUMENTS

NOTE: All the coils in the Transceiver have been preadjusted at the factory and they should be reasonably close to their optimum setting. Adjustments of more than one turn in either direction from the preadjusted setting should not be necessary during this alignment procedure.

RECEIVER SECTION

NOTE: Do not install the antenna on the antenna mounting bracket until instructed to do so later in the alignment procedure.

( ) The unit should be turned on, and the Volume and Squelch controls should be at their maximum clockwise positions.

Adjustments in this alignment section are made to obtain maximum signal in the receiver. Maximum signal can be determined either by listening for the loudest sound in the speaker or by connecting a voltmeter to read the AVC voltage. If a voltmeter is to be used, solder a short piece of wire to the foil alongside the receiver crystal socket as shown in the inset drawing in Figure 4. Connect the negative voltmeter lead to this piece of wire. Connect the positive voltmeter lead to the ground foil at the edge of the circuit board.

( ) Have some one transmit to you on the channel your receiver will tune to (marked on your receiver crystal). Another hand-held transceiver will work well for this purpose. The other transceiver must either be far enough away, or else it should not have its antenna extended, so that your unit receives a weak signal. A weak signal will allow you to make the most accurate adjustments.

( ) Adjust the slug of coil L2 for maximum output, using the plastic alignment tool. Since L2 is the mixer coil, there may be no output at all at certain settings of the slug, nevertheless it should not be necessary to turn the slug more than one complete turn in either direction from its preadjusted position.

NOTE: If you are using a voltmeter to indicate maximum output, the AVC voltage, with no signal input to your receiver, should be about -.5 volt. As a signal is received, this AVC voltage should become less negative. Each adjustment should be peaked to obtain the smallest amount of negative AVC voltage. You may find it necessary to remove the speaker for the following adjustments.

( ) Adjust transformers T1, T2, and T3 for maximum signal output from the speaker (or minimum negative voltage reading on the meter). Do not adjust coil L1 at this time.

TRANSMITTER SECTION

( ) Connect the dummy load (light bulb) from the external antenna lug to the adjacent ground lug as it is shown in Figure 4.

( ) Push the transmit button and adjust coils L5 and L6 for maximum glow of the bulb.

NOTE: Due to the small amount of RF power available, the bulb will glow very dimly in the following step. It is therefore suggested that the following adjustment be made in a dimly lighted area or that the bulb be shaded.

( ) Push the transmit button, and talk or whistle into the microphone (speaker). The light bulb should grow brighter when you speak, indicating that modulation is being applied to the transmitter. If this adjustment or any other adjustment does not give the correct response, refer to the In Case Of Difficulty section.

RF POWER CHECK

If a milliammeter is available, the input power to the final RF amplifier may be checked in the following manner:

( ) Connect the dummy load to the external antenna terminal and to the ground lug as before. See Figure 4.

( ) Unsolder the lead of 68 Ω resistor, R35, from the circuit board as shown in Figure 5.

( ) Set the milliammeter to read between 8 and 11 milliamperes.

( ) Connect the minus (-) lead of the milliammeter to the unsoldered lead of the 68 Ω resistor. Connect the positive (+) lead of the milliammeter to the ground foil at the edge of the circuit board.

INSTRUMENT ALIGNMENT CHART

Equipment needed - A signal generator with a 50 Ω output impedance and a 20,000 ohms-per-volt voltmeter, or a VTVM.

The Volume and Squelch controls should be set to their maximum clockwise positions. Set the voltmeter to its lowest range.

Connect Signal Generator To	Connect Voltmeter to	Adjust for Maximum	Remarks
To the external antenna jack. Note: The signal generator frequency should be the frequency of the channel marked on the receiver crystal. See crystal list on Page 32.	Earphone Jack and chassis ground.	L2	To insure sufficient accuracy of the signal generator, it should be beat against another transmitter on the same channel as the receiver.
"	"	T1, T2, and T3.	Keep the signal generator output low enough so that the voltmeter reads approximately 1 volt.
"	"	L1	"
"	"	L2	"

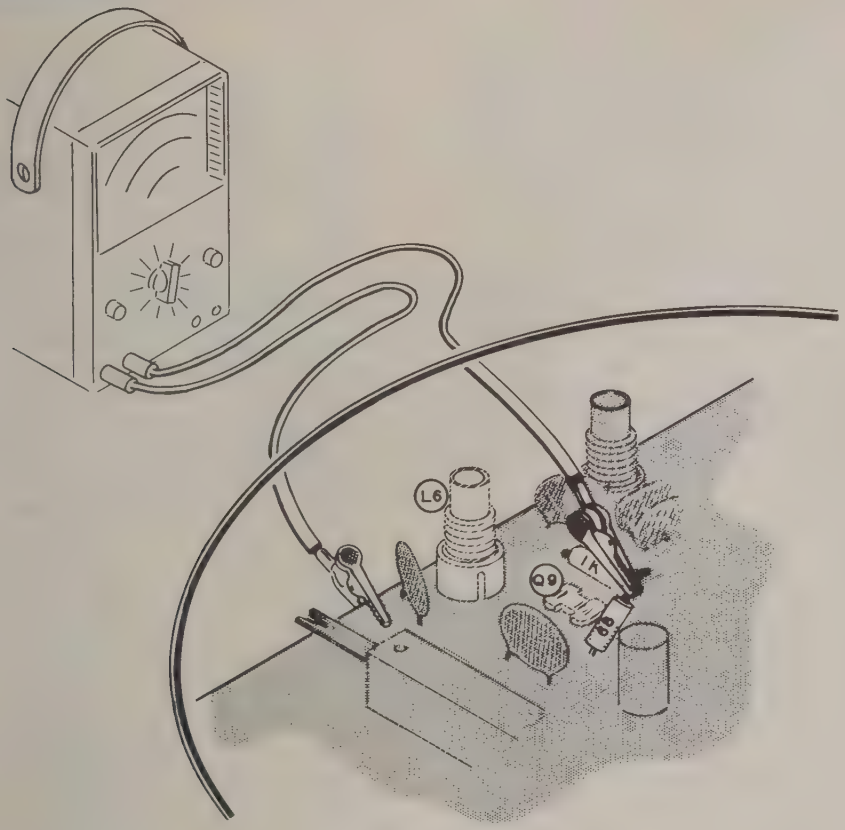


Figure 5

( ) Now turn the Transceiver on, press the transmit button, and note the amount of current being indicated by the meter.

( ) Solder the free lead of the 68 Ω resistor back to its correct place on the circuit board.

( ) With the button depressed, measure the voltage at the junction of C34 and L6.

( ) The final input power can now be computed using Ohm's Law and the current and voltage readings just taken. The following example shows how this might be done.

P = E x I
P = 8 volts x 12 milliamperes
P = 8 x .012 amperes
P = .096 watts
P = 96 milliwatts

NOTE: FCC Rules and Regulations, Part 15, specifies that the input power to the RF amplifier in an unlicensed transmitter must not exceed 100 milliwatts.

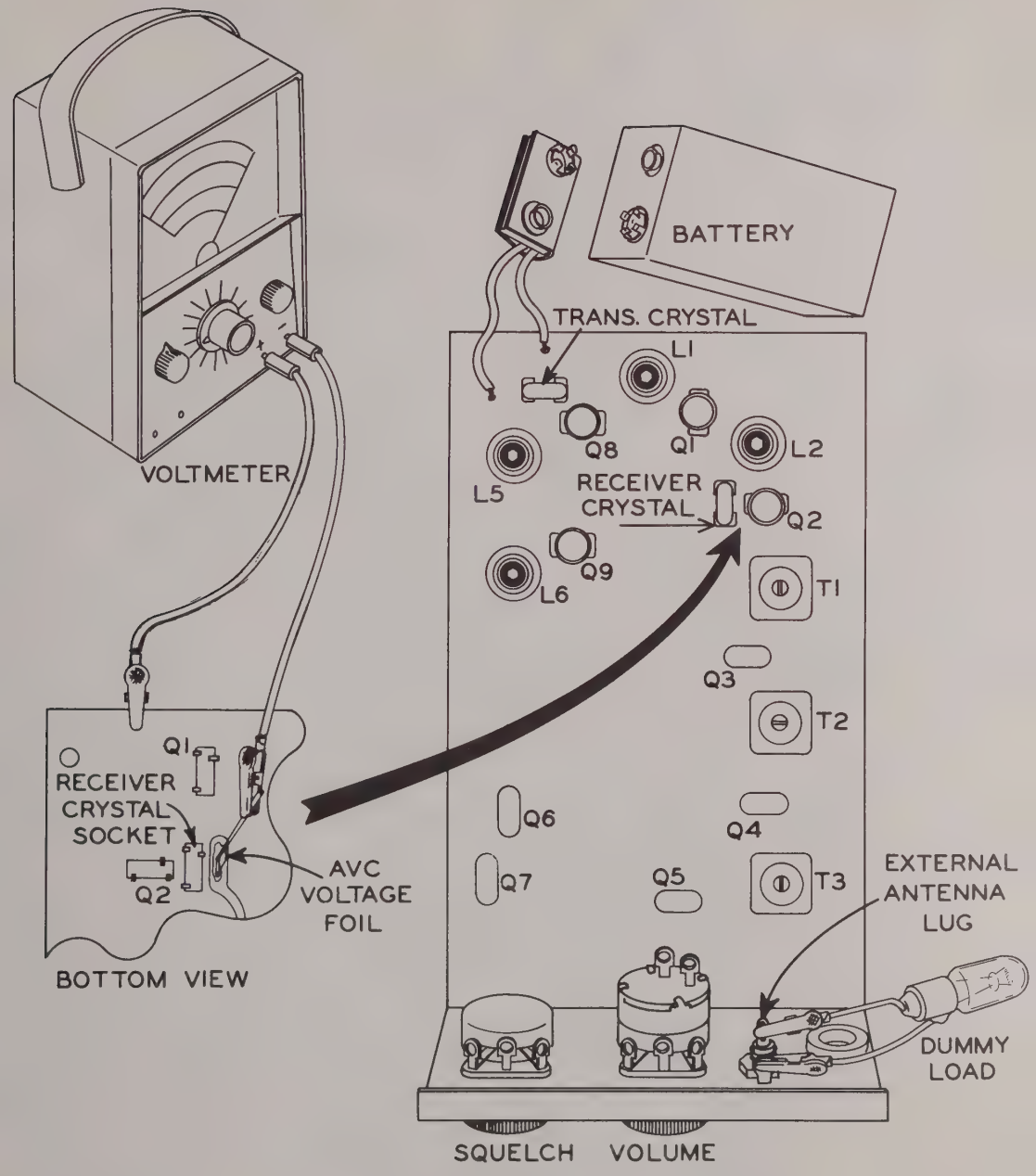
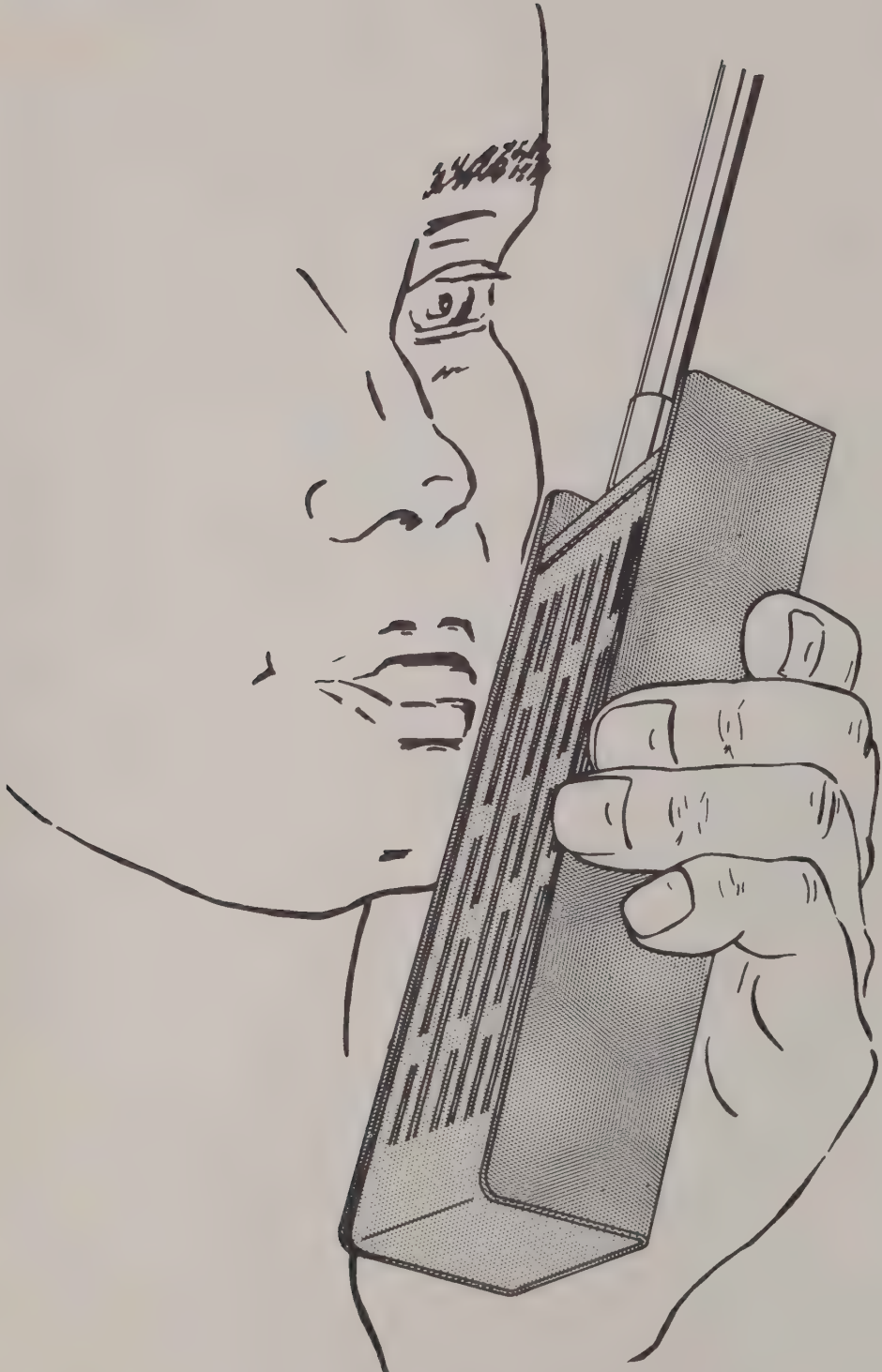

VOLTMETER
BATTERY
TRANS. CRYSTAL
L1
Q8
Q1
L2
L5
RECEIVER
CRYSTAL
Q2
Q9
L6
T1
Q3
T2
Q1
RECEIVER
CRYSTAL
SOCKET
Q2
AVC
VOLTAGE
FOIL
BOTTOM VIEW
Q6
Q4
Q7
Q5
T3
EXTERNAL
ANTENNA
LUG
DUMMY
LOAD
SQUELCH
VOLUME

Figure 4



Pictorial 10

FINAL ADJUSTMENT PROCEDURE

( ) Press the transmit switch, and install the Transceiver in its cabinet as shown in Pictorial 8. Fasten it as shown, with one 6-32 binder head screw, and two sheet metal screws. Fasten the antenna bracket to the circuit board with the screw in that corner of the chassis.

( ) Install the pushbutton knob.

( ) Sign and date the certification label (#390-118). Remove the backing paper from the label and place it as shown, against the inside back of the case.

( ) Remove the backing paper from the battery replacement label (#390-117) and place the label as shown against the inside of the case 1/4" down from the edge of the cabinet.

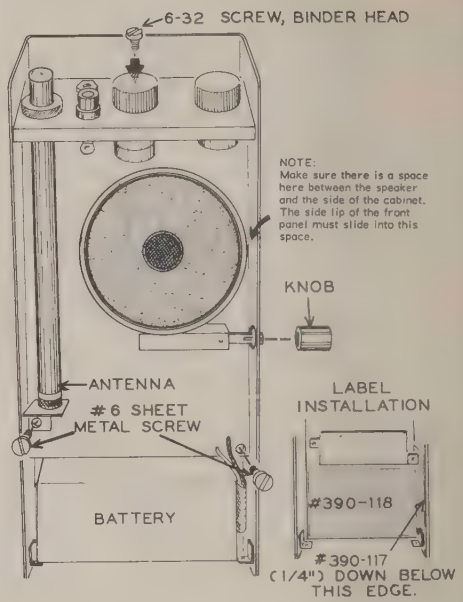
( ) Connect the battery connector to the battery and place the battery in the cabinet.

( ) Press all wires and capacitors near the antenna, position close to the board so they will not interfere with the antenna.

( ) Install the antenna by inserting it down through the plastic grommet and screwing it into the antenna bushing.

Perform the following two steps if you did not use the Instrument Alignment procedure.

( ) Extend the antenna to its full length and have someone transmit to you on the channel to which your receiver is tuned (marked on the side of the receiver crystal). This received signal should be very weak, so weak that you can barely hear it. If another hand-held transceiver is used as the transmitter for this adjustment, its antenna may be pushed down in order to simulate a weak signal.


6-32 SCREW, BINDER HEAD
NOTE:
Make sure there is a space here between the speaker and the side of the cabinet. The side lip of the front panel must slide into this space.
KNOB
ANTENNA
#6 SHEET METAL SCREW
BATTERY
LABEL INSTALLATION
#390-118
#390-117
(1/4") DOWN BELOW THIS EDGE.

Pictorial 8

( ) Adjust coil L1 for the loudest signal. An adjustment of more than one turn from the preadjusted setting should not be needed.

This completes the alignment procedure for your Transceiver.

FINAL ASSEMBLY

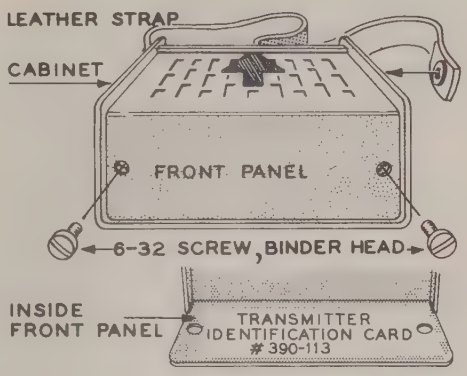
Refer to Pictorial 9 for the following steps.

( ) Fill in the transmitter identification card. Remove the backing paper from the card, and place it as shown inside the front panel.

( ) Install the front panel on the Transceiver as shown in Pictorial 9, using two 6-32 binder head screws. Be sure the top edge of the front panel is below the bent-over edge of the control panel. The ground lug on the phono socket should be bent so that it rests against the inside edge of the panel.

( ) Snap the leather strap in place on the buttons on the side of the cabinet.

This completes the assembly of your Transceiver.



Pictorial 9

OPERATION

Extend the antenna to its full length and turn on the Transceiver with the Volume control. Advance the Volume control to its fully clockwise position. You are now ready to put the unit into operation.

To operate the transmitter portion, the unit should be held in the palm of the hand with the front panel touching your cheek as shown in Pictorial 10. By touching the front panel to your cheek you, in effect, form a ground plane for the antenna and thereby increase transmitting efficiency as well as receiving signal strength. Now, push the transmit button and talk at a normal level into the upper part of the front panel openings. NOTE: Shouting into the unit will cause the modulator to overload, resulting in distortion. To listen, simply release the transmit button.

NOTE: If the Transceiver is to be used as a Class D Citizen's Band station, the complete Part 19 included in the license packet must be read.

The Squelch control may be adjusted to silence the receiver section during the periods of operation when no signals are being received. The squelch circuits are inoperative when this control is in the fully clockwise position. Adjust the Squelch control in the following manner: First, turn the control to its fully clockwise position. Turning the control back just a small amount from this fully clockwise position will give maximum sensitivity to a weak signal while keeping the squelch circuits in operation. As the control is turned further back from the fully clockwise position, the receiver gradually becomes less sensitive, so that it takes stronger and stronger signals to overcome the squelch circuit, thus allowing the signal to be heard.

NOTE: When the Squelch control is in the maximum clockwise position, the squelch and noise limiter diode (D2) has been biased by resistor R21 so that it will still provide good noise limiting. If the unit is generally used in a quiet location where this noise limiting is not needed, R21 can be shorted out to provide a greater volume level in the receiver.

The Earphone Assembly may be plugged into the Earphone Jack if desired.

Any 27 megacycle Class D Citizen's Band antenna may be connected to the External Antenna Socket. If the radiating element of the antenna does not exceed five feet in length, no license will be necessary. If the radiating element of the ex-

ternal antenna exceeds five feet, the Transceiver will have to be licensed as outlined in the accompanying FCC instruction packet.

WIRELESS MIKE APPLICATION

GW-21 Transceivers may be used in wireless microphone applications by plugging the input of a PA amplifier into the Earphone Jack of one transceiver, and using other transceivers as roving microphones on the floor of conventions, etc. See Figure 6. If interference from other Citizen's Band stations becomes a problem in this type of operation, extend the antennas of the transceivers only as far as necessary for good communication. The GW-21 because of its squelch circuit, also makes an ideal paging receiver.

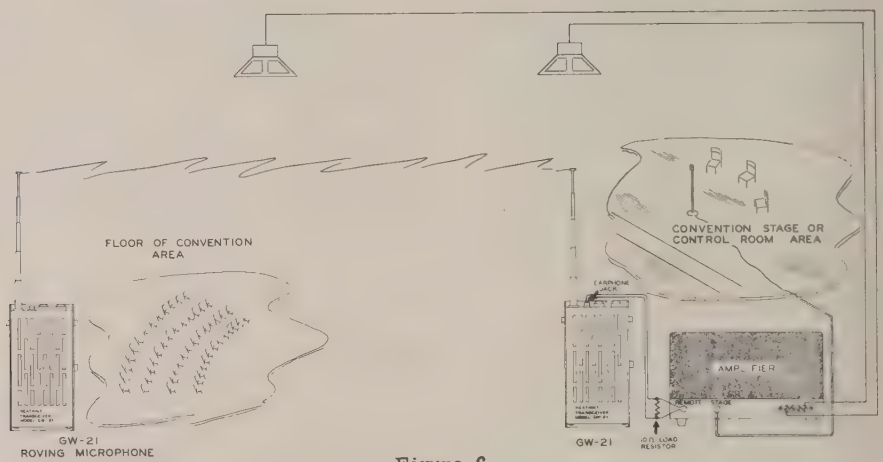


Figure 6

IN CASE OF DIFFICULTY

UNIT FAILS TO OPERATE

1. Recheck the wiring. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits returned for repair malfunction due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections as illustrated in the figure found in the Circuit Board Wiring And Soldering section of this manual.

3. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.

4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

5. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with an 11 megohm input vacuum tube voltmeter. Voltages may vary 10% due to component tolerances.

6. Check transistors with a transistor tester or by substitution of transistors of the same types, known to be good.

7. Check to make sure that the harness wires are connected to the proper holes on the circuit board.

8. A review of the Circuit Description and Schematic Diagram will prove helpful in indicating where to look for trouble.

TROUBLESHOOTING CHART

CONDITION	POSSIBLE CAUSE
Unit completely inoperative.	1. Faulty battery. 2. Off-On switch inoperative.
Receiver dead, Transmitter ok.	1. Squelch control misadjusted. 2. Improper adjustment of coil L2. 3. Earphone Jack open. 4. Open circuit in diode D2. 5. Faulty transistors - Q1, Q2, Q3, or Q4. 6. Faulty receiver crystal X1. 7. Open winding in T1, T2, or T3.
Transmitter dead (dummy load will not glow), Receiver ok.	1. Improper adjustment of coil L5. 2. Faulty transistors, Q8 or Q9. 3. Transmitter crystal X2 faulty. 4. Faulty transformer T5, modulation winding open.
Receiver dead, transmitter has carrier but no modulation.	1. Faulty speaker. 2. Capacitor C21 open. 3. Transformer T4 or T5, open winding. 4. Transistors Q5, Q6, or Q7 faulty.
Receiver motorboats.	1. Capacitor C25 open.
Receiver volume weak, modulation weak.	1. Weak battery. 2. Capacitor C21 or C23 open. 3. Transistor Q5 weak (interchange Q5 with Q6 for a check).
Receiver has poor sensitivity.	1. Weak battery. 2. Improper setting of Squelch control. 3. Receiver not aligned properly. 4. Diode D2 open. 5. Weak transistors - Q1, Q2, Q3, or Q4 (interchange Q3 and Q4 for a check). 6. R19 low in value, R20 or R21 high in value (short out R21 for a test).
Weak transmitter.	1. Weak battery. 2. Antenna not fully extended, Transceiver not operated properly, see Operation section. 3. Improper adjustment of L5 or L6.
Transmitter intermittent when modulated.	1. Turn slug of L5 clockwise 1/2 turn.
Transmitter current too high.	1. R35 low in value.
Receiver current too high.	1. R27 high in value. 2. Leaky transistors Q6 or Q7.
Transmitter modulation distorted.	1. Talking too loud, or shouting, into speaker. 2. Capacitor C32 open.

CONDITION	POSSIBLE CAUSE
Earphone inoperative.	1. Poor contact in earphone jack. 2. Earphone jack lugs reversed; reverse brown and black wires.
Speaker not quieted when earphone is plugged in.	1. Earphone jack contacts not opening properly. 2. Solder blob connected across earphone jack terminals.

SERVICE INFORMATION

SERVICE

If, after applying the information contained in this manual and your best efforts, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment. It is not intended, and is not equipped to function as a general source of technical information involving kit modifications nor anything other than the normal and specified performance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. In a sense, YOU MUST QUALIFY for GOOD technical advice by helping the consultants to help you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case Of Difficulty. Possibly it will not be necessary to write.

2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units and anything else that might help to isolate the cause of trouble.

3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case Of Difficulty. Be as specific as possible and include voltage readings if test equipment is available.

4. Identify the kit model number and date of purchase, if available.

5. Print or type your name and address, preferably in two places on the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like it to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was shipped to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be shipped to you, subject to the terms of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this man-

ner. You may return the completed instrument to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a minimal service fee, plus the price of any additional parts or material required. However, if the completed kit is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase, if possible.

Local Service by Authorized HEATHKIT Service Centers is also available in some areas and often will be your fastest, most efficient method of obtaining service for your HEATHKIT equipment. Although you may find charges for local service somewhat higher than for factory service, the amount of increase is usually offset by the transportation charge you would pay if you elected to return your kit to the Heath Company.

HEATHKIT Service Centers will honor the regular 90 day HEATHKIT Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company; however, it will be necessary that you verify the purchase date of your kit.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if the Service Center assists you in locating a defective part (or parts) in your kit, or installs a replacement part for you, you may be charged for this service.

HEATHKIT equipment purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Warranty.

THIS SERVICE POLICY APPLIES ONLY TO COMPLETED EQUIPMENT CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Equipment that has been modified in design will not be accepted for repair. If there is evidence of acid core solder or paste fluxes, the equipment will be returned NOT repaired.

For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than the Heath Company.

REPLACEMENTS

Material supplied with HEATHKIT products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information.

A. Thoroughly identify the part in question by using the part number and description found in the manual Parts List.

B. Identify the type and model number of kit in which it is used.

C. Mention date of purchase.

D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO. Do not dismantle the component in question as this will void the guarantee. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

In the event that your instrument must be returned for service, these instructions should be carefully followed.

Be sure to return the complete unit installed in its cabinet, with the battery, antenna, transistors, and crystals installed at their correct locations. The earphone assembly should also be returned with the unit, but do not return the

carrying strap.

ATTACH A LETTER TO THE OUTSIDE OF THE CARTON BEARING YOUR NAME, COMPLETE ADDRESS, DATE OF PURCHASE, AND A BRIEF DESCRIPTION OF THE DIFFICULTY ENCOUNTERED. Wrap the equipment in heavy paper, exercising care to prevent damage. Place the wrapped equipment in a stout carton of such size that at least three inches of shredded paper, excelsior, or other resilient packing material can be placed between all sides of the wrapped equipment and the carton. Close and seal the carton with gummed paper tape, or alternately, tie securely with stout cord. Clearly print the address on the carton as follows:

To: HEATH COMPANY
Benton Harbor, Michigan

Include your name and return address on the outside of the carton. Preferably affix one or more "Fragile" or "Handle With Care" labels to the carton, or otherwise so mark with a crayon of bright color. Ship by parcel post or prepaid express; note that a carrier cannot be held responsible for damage in transit if, in HIS OPINION, the article is inadequately packed for shipment.

WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

HEATH COMPANY

EXCERPTS FROM FCC RULES AND REGULATIONS PART 15

Sec. 15.3 General condition of operation. Persons operating restricted or incidental radiation devices shall not be deemed to have any vested or recognizable right to the continued use of any given frequency, by virtue of prior registration or certification of equipment. Operation of these devices is subject to the conditions that no harmful interference is caused and that interference must be accepted that may be caused by other incidental or restricted radiation devices, industrial, scientific or medical equipment, or from any authorized radio service.

Sec. 15.4 (f) Low power communication device. A low power communication device is a restricted radiation device, exclusive of those employing conducted or guided radio frequency techniques, used for the transmission of signs, signals (including control signals), writing, images and sounds or intelligence of any nature by radiation of electromagnetic energy.

Examples: Wireless microphone, phonograph, oscillator, radio controlled garage door opener and radio controlled models.

Sec. 15.201 Frequencies of operation.
(a) A low power communication device may be operated on any frequency in the bands 10-490 kc, 510-1600 kc and 26.97-27.27 mc.

Sec. 15.205 Operation within the frequency band 26.97-27.27 mc. A low power communication device may operate within the band 26.97-27.27 mc (27.12 mc ±150 kc) provided it complies with all of the following requirements:

(a) The carrier of the device shall be maintained within the band 26.97-27.27 mc.

(b) All emissions, including modulation products, below 26.97 mc or above 27.27 mc shall be suppressed 20 db or more below the unmodulated carrier.

(c) The power input to the final radio stage (exclusive of filament or heater power) shall not exceed 100 milliwatts.

(d) The antenna shall consist of a single element that does not exceed 5 feet in length.

Sec. 15.208 Certification requirements.
(a) No low power communication device manufactured after January 1, 1958 shall be operated without a station license unless it has been certificated to demonstrate compliance with the requirements in this part.

(b) The owner or operator need not certificate his own low power communication device if it has been certificated by the manufacturer or distributor.

(c) Where certification is based on measurement of a prototype, a sufficient number of units shall be tested to assure that all production units comply with the technical requirements of this subpart.

(d) The certificate may be executed by a technician skilled in making and interpreting the measurements that are required to assure compliance with the requirements of this part.

(e) The certificate shall contain the following information:

(1) The operating conditions under which the device is intended to be used.

(2) The antenna to be used with the device.

(3) A statement certifying that the device can be expected to comply with the requirements of this subpart under the operating conditions specified in the certificate.

(4) The month and year in which the device was manufactured.

Sec. 15.209 Location of certificate. The certificate shall be permanently attached to the device and shall be readily visible for inspection.

Sec. 15.210 Interference from low power communication devices. Notwithstanding the other requirements of this part, the operator of a low power communication device, regardless of date of manufacture, which causes harmful interference to an authorized radio service, shall promptly stop operating the device until the harmful interference has been eliminated.

Reprinted by Heath Company from FCC Rules and Regulations, Part 15.

TRANSMITTER CRYSTAL LIST

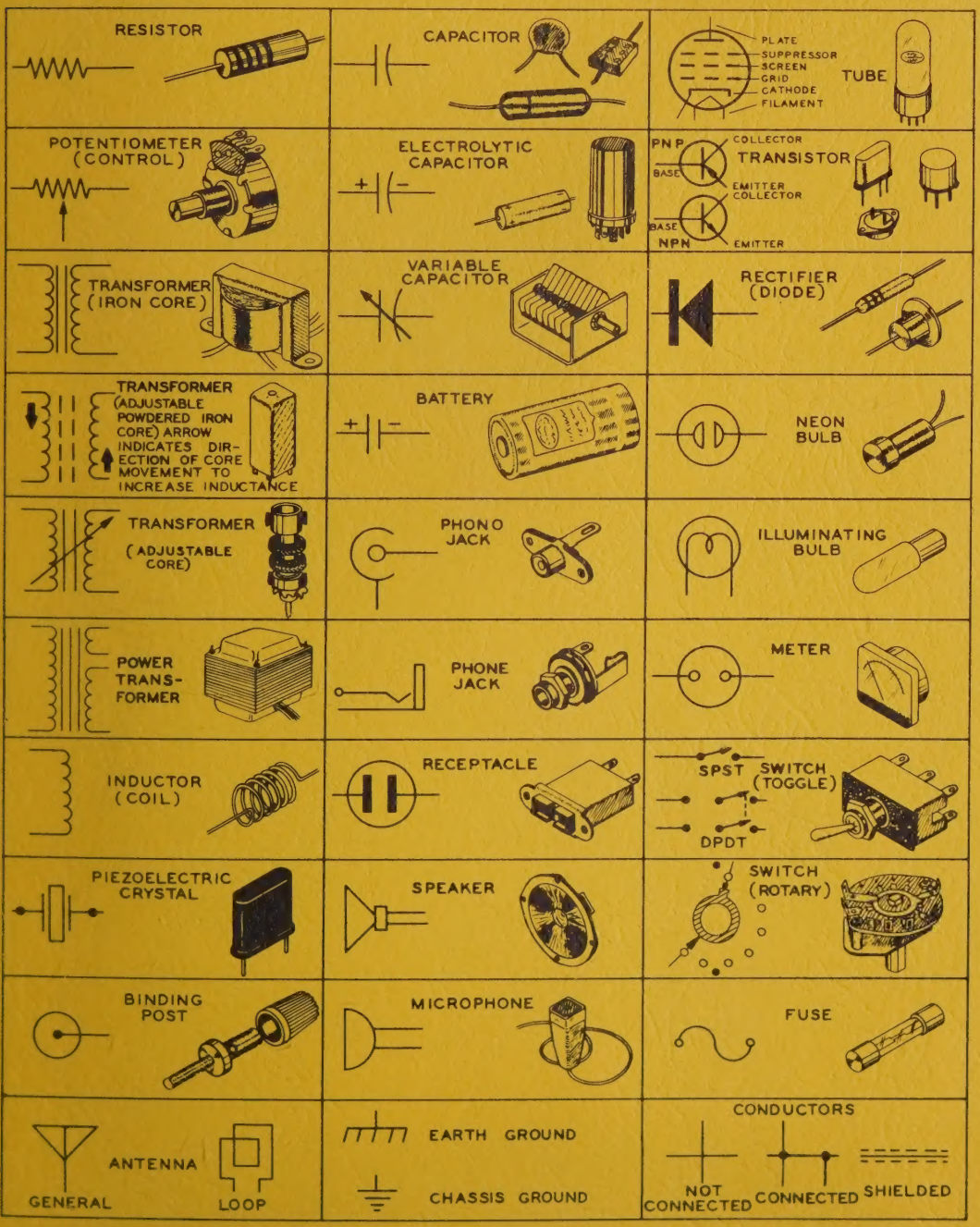
CHANNEL	PART NO.	FREQUENCY, MC
1	404-67	26.965
2	404-68	26.975
3	404-69	26.985
4	404-70	27.005
5	404-71	27.015
6	404-72	27.025
7	404-73	27.035
8	404-74	27.055
9	404-75	27.065
10	404-76	27.075
11	404-77	27.085
12	404-78	27.105
13	404-79	27.115
14	404-80	27.125
15	404-81	27.135
16	404-82	27.155
17	404-83	27.165
18	404-84	27.175
19	404-85	27.185
20	404-86	27.205
21	404-87	27.215
22	404-88	27.225
23	404-89	27.255

RECEIVER CRYSTAL LIST

CHANNEL	PART NO.	FREQUENCY, MC
1	404-157	27.420
2	404-158	27.430
3	404-159	27.440
4	404-160	27.460
5	404-161	27.470
6	404-162	27.480
7	404-163	27.490
8	404-164	27.510
9	404-165	27.520
10	404-166	27.530
11	404-167	27.540
12	404-168	27.560
13	404-169	27.570
14	404-170	27.580
15	404-171	27.590
16	404-172	27.610
17	404-173	27.620
18	404-174	27.630
19	404-175	27.640
20	404-176	27.660
21	404-177	27.670
22	404-178	27.680
23	404-179	27.710

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



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